NORTHEAST FLOOD STUDIES

INTERIM REPORT
ON
REVIEW OF SURVEY

HOUSATONIC RIVER BASIN

NAUGATUCK RIVER

CONNECTICUT

U.S. Army Engineer Division, New England
Corps of Engineers
Boston, Mass.

30 JUNE 1958

ARMY-NED-BOSTON

SYLLABUS

The Division Engineer finds that there is need for revision of the existing flood control plan for the Naugatuck River in order to insure the stability of present development, the security of the inhabitants, and the preservation of existing economic values. He finds that the Naugatuck River causes major damages along its watercourse through the highly industrialized Naugatuck Valley. He concludes that flood control measures, in addition to the authorized reservoirs, are necessary and economically justified.

The Division Engineer recommends that the authorized plan for flood control in the Naugatuck River Basin be modified to provide for the construction of flood control dams and reservoirs on Northfield Brook, Branch Brook, Hancock Brook, and Hop Brook at a total estimated first cost to the United States of $10,230,000 exclusive of pre-authorization costs, provided local interests establish encroachment lines downstream of the dams to permit reasonable, efficient reservoir operation.

(R 12/31/58)

INTERIM REPORT ON REVIEW OF SURVEY
HOUSATONIC RIVER BASIN
NAUGATUCK RIVER, CONNECTICUT

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OFFICE OF THE DIVISION ENGINEER
U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
BOSTON, MASSACHUSETTS

30 June 1958

SUBJECT: Interim Report on Review of Survey for Flood Control, Housatonic River Basin, Naugatuck River, Connecticut

TO: Chief of Engineers
Department of the Army
Washington 25, D. C.
ATTENTION: ENGWF

SECTION I - AUTHORITY

1. AUTHORIZING RESOLUTIONS

This report is submitted pursuant to authority contained in the following Congressional resolutions which are quoted in part:

a. Resolution by the Committee on Public Works of the United States Senate, adopted September 14, 1955:

> That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review previous reports on the . . . Housatonic River, Connecticut, Massachusetts and New York . . . in the area affected by the hurricane flood of August 1955, to determine the need for modification of the recommendations in such previous reports and the advisability of adopting further improvements for flood control and allied purposes in view of the heavy damages and loss of life caused by such floods.

b. Resolution by the Committee on Public Works of the House of Representatives, adopted June 13, 1956:

> That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on the Housatonic River, Connecticut, Massachusetts, and New York, published as House Document 338, 77th Congress, and other pertinent reports, with a view to determining what improvements for flood control are advisable at this time, with particular reference to the following areas and locations: Naugatuck River

Basin for protection at Derby-Ansonia, Seymour, Beacon Falls, Naugatuck-Union City, Waterbury-Watertown, Waterville, Thomaston, and Torrington, Connecticut: and with further particular reference to the construction of dikes and other improvements for flood control on the lower reaches of the Housatonic River.

c. Resolution by the Committee on Public Works of the House of Representatives, adopted July 23, 1956:

> That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on the Housatonic River, Connecticut, Massachusetts, and New York, published as House Document 338, 77th Congress, and other reports, with a view to determining the advisability of providing improvements in the interest of flood control and allied purposes on the Naugatuck River, with particular reference to Beacon Falls, Seymour, Ansonia, and Derby, Connecticut, at this time.

2. ASSIGNMENT OF STUDY

a. In letter dated September 14, 1955, the Chairman of the Committee on Public Works of the United States Senate transmitted the foregoing Senate Resolution to the Chief of Engineers and requested appropriate attention. By first indorsement dated September 16, 1955, the Chief of Engineers assigned the study and the preparation of a report to the Division Engineer, U. S. Army Engineer Division, New England.

b. In letters dated June 18, 1956 and July 25, 1956, respectively, the Chairman of the Committee on Public Works of the House of Representatives transmitted the foregoing House Resolutions to the Chief of Engineers. By first indorsements dated, respectively, July 26, 1956 and August 3, 1956, the Chief of Engineers referred the resolutions to the Division Engineer, U. S. Army Engineer Division, New England.

SECTION II - SCOPE

3. SCOPE OF REPORT

This interim report of survey scope comprises a review of flood problems in the watershed of the Naugatuck River, the major tributary of the Housatonic River, with particular consideration to the lower Naugatuck River below the authorized Thomaston Dam and Reservoir. Flood problems and solutions considered for the upper Naugatuck River above the Thomaston Dam are covered in a previous report cited in paragraph 5d. Local protection for Ansonia will be discussed in a supplemental report. The purpose of the report is to determine the advisability and economic feasibility of further flood control improvements and to make specific recommendations in the interest of flood control and allied purposes.

4. SCOPE OF STUDIES

a. Topographic surveys. U. S. Army Map Service, Geological Survey and local maps were used in the study. Topographic surveys made especially for this study consisted of centerline profiles at potential dam sites.

b. Site explorations. Geologic reconnaissance was made of all potential dam sites. Subsurface explorations were accomplished by means of drive-sample bore holes at those sites where there were no extensive ledge outcrops.

c. Economic investigations. Surveys of flood damages were made after the floods of 1938, 1948, and 1955. The surveys consisted of personal interviews with municipal and State officials, officers of industrial concerns, and private individuals experiencing losses.

d. Office studies. Office studies consisted of hydrologic and hydraulic analyses and determination of approximate quantities and costs of the major items of construction and relocations.

e. Real estate studies. Field reconnaissance and determination of recent sales in the reservoir area were used as the basis for real estate costs.

f. Consultations with interested parties. A public hearing was held in Waterbury, Conn., on December 11, 1956, at which time interested parties requested consideration of improvements in various areas in the Naugatuck River Basin and commented on potential dam sites then under consideration. A synopsis of the hearing is given in Section XIV. Meetings have been held with State and local officials, the Naugatuck Valley River Control Commission, and with private individuals.

g. Field reconnaissance. Field reconnaissance of the problem areas and sites of potential improvements has been made by the Division Engineer and representatives of his office.

SECTION III - PRIOR REPORTS

5. PUBLISHED REPORTS

Flood control in the Naugatuck River and its tributaries has been considered in the following published reports on the Housatonic River Basin:

a. "308" Report. A report dated June 25, 1931 and printed as House Document No. 246, 72d Congress, 1st session, covered navigation, water power, flood control, and irrigation in the Housatonic River Basin. The report found that further improvements were not warranted at that time.

b. 1940 Report. A report dated Jun 20, 1940 and printed as House Document No. 338, 77th Congress, 1st session, recommended construction of the Thomaston Dam on the Naugatuck River above Thomaston, Conn. This project was authorized by Public Law 534, 78th Congress, 2d session, approved December 22, 1944.

c. NENYIAC Report. Flood control and allied water uses are also considered in Part 2, Chapter XXII, "Housatonic River Basin," of The Resources of the New England-New York Region. This comprehensive report inventoried the resources of the New England-New York area and recommended a master plan to be used as a guide for the regional planning, development, conservation, and use of land, water, and related resources of the region. Also included were proposals to reduce flood losses. Prepared by the New England-New York Interagency Committee, the report was submitted to the President of the United States by the Secretary of the Army on April 27, 1956. Part 1 and Chapter I of Part 2 are printed as Senate Document 14, 85th Congress, 1st session.

d. 1956 Interim Report. An interim report dated May 31, 1956 and printed as House Document No. 31, 85th Congress, 1st session, reviewed the need for additional flood control works on the upper Naugatuck River upstream from the authorized Thomaston Reservoir. The report of the Chief of Engineers recommended that the authorized plan for flood control in the Housatonic River be modified to provide for the construction of 2 flood control dams and reservoirs, 1 on Hall Meadow Brook and 1 on the East Branch of the Naugatuck River.

SECTION IV - DESCRIPTION

6. LOCATION AND EXTENT

The Naugatuck River Basin, the largest subbasin of the Housatonic River watershed, is located in the western part of Connecticut, primarily within the confines of Litchfield and New Haven Counties. A small portion of the basin also extends into Hartford County. The Naugatuck watershed has a maximum length of approximately 50 miles, a maximum width of about 12 miles, and a total drainage area of 312 square miles. A map of the Naugatuck River watershed is shown on Plate No. 1

7. TOPOGRAPHY

The Naugatuck Basin is hilly, with wooded hilltops and cleared valleys, the latter devoted to cities and manufacturing. Elevations vary from near mean sea level to a maximum of 1,770 feet above mean sea level along the northern divide of the watershed. The hills along the watershed rise to heights about 700 feet above the valley. The topography of the entire drainage area is shown on United States Geological Survey Maps at a scale of 1"=1/2 mile (1:31,680) with 10-foot contour intervals.

8. GEOLOGY

The Housatonic River Basin is mainly in the Upland Section of the New England Physiographic Province. It is a maturely dissected upland with narrow, flat-topped hills preserving in their relatively accordant summits the old, uplifted plain into which the present valleys have been incised. The valleys are generally well developed and well graded with few lakes or poorly drained, swampy reaches.

The bedrock of the region consists of Paleozoic and older, Archean rocks which have been folded and faulted. The early Paleozoic rocks, Cambrian and Ordovician shale and limestone, were metamorphosed to become the schist and marble which make the present ridges and valleys along the main axis of the Housatonic valley. The Naugatuck and most of the other tributaries of the Housatonic flow through regions of hard rocks, schist, granite, and gneiss.

The overburden throughout the basin consists of till and outwash. A thin veneer of till composed of variable, silty, gravelly sand with cobbles and boulders covers the sides and crests of the hills in the basin except where rock is exposed on very steep slopes or along very narrow ridges. The valley bottoms are generally deeply filled with glacial till. Detritus, consisting of sand, silt, and gravel washed off the ice, was carried downstream and spread out across the valley floors, burying the till. Erosion since the disappearance of the glacier has left remnants of the outwash deposits which occur as scattered terraces on one or both walls of the present valleys.

9. STREAM CHARACTERISTICS

a. Main stream. The Naugatuck River is formed in the city of Torrington by the confluence of its West and East Branches, at an elevation of approximately 525 feet above mean sea level. The river flows generally south for about 40 miles, entering the Housatonic River at the town of Derby, about 12 miles above Long Island Sound. The Naugatuck River has a fall of about 520 feet. The stream is fed by relatively small, steeply falling brooks.

b. Tributaries. The principal tributaries of the Naugatuck River are the West Branch, the East Branch, Leadmine Brook, Branch Brook, Hancock Brook, Steel Brook, Mad River, Hop Brook, Bladens River, and Little River.

(1) The West Branch has its source in the northwest corner of the town of Torrington at the confluence of 2 brooks and flows in a general south-southeasterly direction for about 6 miles to its confluence with the East Branch in the city of Torrington. It has a drainage area of about 34 square miles and a fall of about 270 feet.

(2) The East Branch rises at Lake Winchester in the southwest portion of the town of Winchester and flows in a generally southerly direction for about 9 miles to its confluence with the West Branch at Torrington. It has a drainage area of about 14 square miles and a fall of about 729 feet.

(3) Leadmine Brook is formed by its East and West Branches in the north-central part of the town of Harwinton and flows generally south for about 7 miles to enter the Naugatuck River in the northwest corner of the town of Thomaston. It has a drainage area of 24 square miles and a fall of about 340 feet.

(4) Branch Brook has its source in Wigwam Reservoir in western Thomaston, flows in an erratic southeast course for about 4.5 miles to its confluence with the Naguatuck in Mattatuck State Forest. It drains an area of approximately 23 square miles and has a fall of about 250 feet.

(5) Hancock Brook rises in the southwest portion of the town of Bristol and flows in a southwesterly course for 10 miles to its confluence with the Naugatuck, north of the city of Waterbury. It has a drainage area of 16 square miles and a fall of 330 feet.

(6) Steel Brook starts at Smith Pond in north-central Watertown and flows generally south-southeast for about 7 miles to enter the Naugatuck at Waterbury. Its drainage area is about 17 square miles and its fall is 427 feet.

(7) Mad River has its source at Scovill Reservoir in south-central Wolcott and flows in an erratic southwesterly course for 6.5 miles to enter the Naugatuck in Waterbury. It has a drainage area of 26 square miles and a fall of 450 feet.

(8) Hop Brook rises in northwestern Middlebury and flows in a meandering south-southeasterly direction for 9 miles to enter the Naugatuck at the northern part of the borough of Naugatuck. Its drainage area is 17 square miles; its fall, 450 feet.

(9) Bladens River begins in north-central Woodbridge and flows west for about 4.5 miles, entering the Naguatuck at Seymour. It has a drainage area of 11 square miles; a fall of 355 feet.

(10) Little River has its source in the north of Oxford and flows south-southeast to the Naugatuck at Seymour. It has a length of 8.5 miles, a drainage area of 15 square miles, and a fall of 560 feet.

c. Profiles. Profiles of the Naugatuck River and its principal tributaries are shown on Plate No. 2.

SECTION V - ECONOMIC DEVELOPMENT

10. POPULATION

a. General. There are 28 towns lying wholly or partly within the Naugatuck River Basin. There are also 5 cities and 1 borough coextensive with the towns in which they are located. The population of the basin, according to estimates based on the 1950 U. S. Census, numbers more than 215,200.

b. Distribution. The population of the Naugatuck River Basin is approximately 90 percent urban and 10 percent rural. Ten of the 28 towns have only negligible portions of their populations in the basin. Of the remaining 18 towns, 12 are at least partly urban. Almost half of the basin's population is located in the city of Waterbury.

c. Concentration. The largest municipality in the basin is the city of Waterbury with a 1950 population of 104,477. Other sizable municipalities in the basin are Torrington with a population of 27,820; Ansonia, population 18,706; and Naugatuck, population 17,455. Other places largely or wholly within the Naugatuck River Basin having populations in excess of 10,000 are Watertown and Derby.

11. TRANSPORTATION

The transportation needs of the Naugatuck River Basin are served by the New Haven Railroad, 3 major buslines, and numerous trucking companies.

a. Railroads. Seven towns have passenger and freight train service and 5 additional towns have freight train service only. The Naugatuck Valley Branch of the New Haven Railroad, which follows the Naugatuck River for its entire length, and a branch line from Waterbury to Hartford make rail service accessible to every part of the basin.

b. Buslines. Eight of the basin's towns, including 4 which do not have passenger train service, are on direct bus routes to New York City, Albany, Burlington, Pittsfield, Springfield, Worcester, Boston, and Providence. Local service links Waterbury to Hartford, New Haven, and Winsted; and Torrington to Hartford and Winsted.

c. Highways. The entire basin is crisscrossed by a network of paved roads and every town in the basin is within access to one or more of the sizable shopping centers within the basin itself. The main route in the network is State Route 8 which traverses the basin from north to south, following the Naugatuck River for its entire length and linking together almost all of the basin's communities.

d. Airfields. There are several small, privately owned and operated airfields in the basin but no scheduled stops for any commerical airline.

12. MANUFACTURING

a. Extent of manufacturing. Manufacturing plays the major role in the economy of the Naugatuck River Basin. Approximately 1 of every 4 persons living in the basin is employed in manufacturing, and more than half of the towns located in the basin (excluding 10 towns which have only negligible portions of their populations and areas in the basin) engage in manufacturing to some extent.

b. Distribution of industry. Although the city of Waterbury, located almost in the middle of the basin, accounts for approximately 45 percent of the employed manufacturing workers of the basin, manufacturing activity is distributed throughout the entire watershed. The city of Torrington accounts for about 16 percent of the manufacturing in the basin, while the Borough of Naugatuck is a close third with 15 percent.

c. Leading industries. The most widespread and by far the most important industrial activity in the basin is the manufacture of a variety of small metal products. The fabricated metal and machinery industries constitute about 56 percent of the basin's manufacturing industry. The Naugatuck Valley comprises the leading non-ferrous metal manufacturing area in the nation. Over one-third of the nation's brass and bronze is produced in this area. Other leading industries of the Naugatuck River Basin are the rubber goods industry, employing about 12.5 percent of all manufacturing workers, and the clock and watch industry, employing about 11 percent.

d. Important manufacturing centers and their products. The more important manufacturing centers in the basin and their principal products are: Waterbury--fabricated metals and machinery, clocks and watches, plastics, textiles, printing and publishing, food products, electrical and electronics components, paper products, and chemicals; Torrington--needles and bearings, fabricated brass products, sporting goods, wire forming machinery, propeller blades and blower wheels, gaskets and oil seals, drapery hardware, and metal stamping; Naugatuck--rubber footwear, rubber byproducts, candy, and recording instruments; Ansonia--fabricated brass products, gears and machinery, screw machine products, metal stampings, and light assemblies; Watertown--textiles, pins, hooks and eyes, snaps, paper clips, thimbles, drapery hardware, plastics, and bathroom, kitchen, and closet accessories; Seymour--pens and mechanical pencils, writing inks, insulated wire and cables, anodes, metal goods, and specialties; Derby--gears and machinery; Thomaston--fabricated metal products and brass mill products, and clocks and timing devices; Middlebury--clocks and watches.

13. NATURAL RESOURCES

a. Water supply. Of the Naugatuck River Basin communities having public water supplies, only Watertown uses ground water, all others utilizing surface water sources. The available surface water resources in the basin are reported to be almost completely utilized, and it is anticipated that water supply available to most of the Naugatuck River Valley will become inadequate by the year 2000. Assuming a doubling of water use by that time, the most critical areas in the basin will be Ansonia, Derby, Naugatuck, Seymour, Torrington, Waterbury, and Watertown. The City of Waterbury already diverts a large part of its water supply from the headwaters of the Shepaug River, another tributary of the Housatonic. This supply has a safe yield of only about 30 million gallons per day, and Waterbury uses an average of 61 million gallons per day. Extensive reuse of river water is practiced at Waterbury, with a number of manufacturing plants using raw river water for industrial processes and cooling and returning the major portion to the river within a relatively short time. For future expansion in all of the critical communities of the basin, more intensive reuse, storage, and/or diversion of water into the basin will be required.

b. Water power. There are no utility-owned hydroelectric plants in the basin. Nine industrial plants, with a total installed capacity of about 2,200 horsepower, utilize approximately 121 feet of head at 7 locations on the Naugatuck River and its West Branch. There are no known, undeveloped hydroelectric power sites remaining in the basin.

c. Recreational use of water. There are 7 state forests and parks located wholly or partly within the Naugatuck River Basin, providing opportunities for fishing, hunting, camping, swimming, and picnicking. There are also many small lakes and ponds in the basin, some of which -- particularly in the Plymouth-Wolcott area -- have sizable numbers of summer homes. Most of the recreational facilities are for the use of local residents primarily.

d. Forestry. Although about 60 percent of the basin is under forest cover, intensive use of forest resources and wasteful cutting methods in the past have left the timber stand in poor condition. Few permanent types of wood-using industries are now located in the basin. Most existing stands are of pole timber size, being too small for saw-log operations but large enough for cordwood. There are areas of sawtimber, seedlings, and saplings, and a few small areas of poorly stocked and denuded land.

e. Agriculture. With the population of the Naugatuck River Basin predominantly urban, agriculture plays a relatively unimportant role in the economy of the basin. Agriculture is confined to the narrow valley floors, and adverse topographical and soil conditions have contributed to the gradual abandonment of rougher lands of low productivity which are gradually reverting to woodland. The small proportion of land in the basin used for agricultural purposes is mostly in hay or pasturage, with some production of dairy products, potatoes, and truck vegetables.

f. Mineral resources. There are few minerals of commercial value to be found in the area. One quarry at Seymour produces crushed stone and small blocks of granite for curbing and similar uses. Sand and gravel deposits exist in the basin and are commercially utilized.

SECTION VI - CLIMATOLOGY

14. GENERAL

The climate of the Naugatuck River Basin is generally moderate. In the southern portion of the basin, due to the tempering influence of nearby Long Island Sound, summers are not excessively hot and winters are generally mild, with hot spells in summer and cold periods in winter usually being of short duration. This moderating influence decreases with the distance from the coast, so that the winters are colder at the higher elevations in the northern part of the watershed. The basin is subject to frequent but short periods of heavy precipitation. The basin lies in the paths of the "prevailing westerlies," which often include cyclonic disturbances that cross the country from the west or southwest and converge on the Northeast. It is also exposed to occasional coastal storms that travel up the Atlantic Seaboard, some being of tropical origin and of hurricane intensity.

15. TEMPERATURE

The average annual temperature in the Naugatuck River Basin is about 47° F., ranging from about 50° F. in the southern part to about 45° F. in the headwaters. Average monthly temperatures vary widely throughout the year. The lowest recorded temperature in the basin was -25° F., the highest, 105° F. Freezing temperatures can be expected from the middle of November until the end of March.

16. PRECIPITATION

The average annual precipitation over the Naugatuck River Basin is about 50 inches, uniformly distributed throughout the year. During the 67 years of record through 1954, maximum and minimum annual precipitations at Waterbury were 66.58 inches in 1901 and 32.21 inches in 1931, respectively. The Waterbury gage was lost in the August 1955 storm and records are not available for the period August through December 1955. Annual precipitation for 1955 has been estimated at approximately 65 inches. At Norfolk, at the upper limits of the watershed, the total precipitation for 1955 was 76 inches with 23.67 and 17.49 inches observed during August and October, respectively. The annual snowfall over the watershed varies from about 35 inches near the coast to over 80 inches in the headwaters region. The average snowfall for 37 years of record at Norfolk is 80.3 inches. The water content of the snow cover in the early spring often totals 4 to 6 inches.

SECTION VII - RUNOFF AND STREAMFLOW DATA

17. GAGING STATION RECORDS

The U. S. Geological Survey has published records of river stages and streamflows at 4 locations in the basin for various lengths of time since 1918. The records are generally good to excellent, except during periods of ice when they are fair. The locations of stream-gaging stations in the basin, together with their respective drainage areas and periods of record, are listed in Table 1.

TABLE 1

GAGING STATIONS - NAUGATUCK RIVER BASIN

Location	Drainage Area (sq. miles)	Period of Record
Leadmine Brook near Thomaston, Conn.	24.0	1930 -
Naugatuck River near Thomaston, Conn.	71.9	1930 -
Naugatuck River near Naugatuck, Conn.	246	1918 - 1924 1929 - 1955
Naugatuck River near Beacon Falls, Conn.	261	1955 -

SECTION VIII - FLOODS OF RECORD

18. HISTORIC FLOODS

The earliest recorded flood of significance in the Naugatuck River Basin occurred in February 1691. Two large floods were recorded in November 1853 and April 1854. The flood of October 1869 was the greatest prior to 1900, with other serious floods occurring in 1874, 1888, 1891, 1896, and 1897. There is no reliable information on the magnitudes of any of these floods.

19. RECENT FLOODS

The Naugatuck River Basin has experienced 6 major floods within the past 30 years. These major floods are briefly described in the following paragraphs, with a summary of comparative flood magnitudes of the last 3 indicated in Table 2 on page 17.

a. November 1927. This flood resulted from a rainfall of 5.5 inches that fell during November 3 and 4 on ground saturated by rains during the previous month.

b. March 1936. This flood was caused by 4 distinct storm centers that passed over the northeastern states between March 9 and 22. The runoff from the rains was augmented by considerable snowmelt.

c. September 1938. This flood resulted from the heavy rainfall that accompanied the tropical hurricane which passed over New England on September 21. The rain fell on ground saturated by rains earlier in the month. The average rainfall over the Naugatuck River Basin during this storm exceeded 10 inches.

d. December 1948. This flood resulted from about 9 inches of rain falling on frozen ground. The runoff was augmented by snowmelt.

e. August 1955. The greatest flood of record was caused by rainfall that preceded and accompanied hurricane Diane. Rainfall, which averaged more than 13 inches in the upper watershed and 10 inches in the lower part of the basin, followed more than 7 inches of rain left the previous week by hurricane Connie. The resultant flood, estimated to have reached 41,600 cubic feet per second at Thomaston and 106,000 cubic feet per second at Naugatuck, was approximately 4 times the size of the previous maximum flood of record.

f. October 1955. This flood resulted from a storm that moved up the Atlantic Coast from Florida and deposited 10 to 14 inches of rainfall over the lower half of the Naugatuck River Basin.

20. FLOOD CHARACTERISTICS

The more critical floods, which can occur in any month of the year, develop from rainfall alone where the intensity of the rainfall, rather than the total volume, may determine the magnitude of the flood peaks. The quick development of floods is due to the many short, steep tributaries which empty into the main channel concurrently. This is illustrated by the fact that, in major floods, the Naugatuck River has crested along its entire length within a period of 5 to 8 hours.

SECTION IX - STANDARD PROJECT FLOOD

21. GENERAL

The magnitude of the August 1955 flood made it necessary to reappraise the flood potentials of the Naugatuck River Basin. Analyses of the 1955 flood indicated a substantial increase in the magnitude of the unit hydrographs previously used for determination of the standard project flood in this basin, particularly for intense storms following an antecedent wet period. Determination of the standard project storm and the development of the storm pattern followed procedures described in Civil Engineer Bulletin 52-8, Standard Project Flood Determinations. Magnitudes of the standard project flood and major floods of record are compared in Table 2.

TABLE I-2

COMPARISON OF ANNUAL CHARGES AND BENEFITS BASED ON 50-YEAR AND 100-YEAR ECONOMIC LIFE

RECOMMENDED RESERVOIRS

	Northfield Brook Dam and Reservoir		Black Rock Dam and Reservoir		Hancock Brook Dam and Reservoir		Hop Brook Dam and Reservoir	
	50-Year	100-Year	50-Year	100-Year	50-Year	100-Year	50-Year	100-Year
	$	$	$	$	$	$	$	$
First Costs	1,620,000	1,620,000	3,550,000	3,550,000	2,520,000	2,520,000	2,600,000	2,600,000
Annual Charges								
Interest	41,500	41,500	91,100	91,100	64,600	64,600	66,600	66,600
Amortization	16,800	3,800	36,300	8,200	25,800	5,800	25,500	5,700
Maintenance	5,000	5,000	9,000	9,000	5,000	5,000	9,000	9,000
Interim replacements			1,000	1,400			1,000	1,300
Net loss of taxes	1,000	1,000	3,700	3,700	2,800	2,800	11,100	11,100
Total Annual Charges	64,300	51,300	141,100	113,400	98,200	78,200	113,200	93,700
Annual Benefits(1)								
7-Reservoir System								
Benefits	129,000	129,000	258,000	258,000	183,000	183,000	193,000	193,000
Benefit:Cost Ratio	2.0	2.5	1.8	2.3	1.9	2.3	1.7	2.1
8-Reservoir System A								
Benefits	128,000	128,000	269,000	269,000	198,000	198,000	182,000	182,000
Benefit:Cost Ratio	2.0	2.5	1.9	2.4	2.0	2.5	1.6	1.9
8-Reservoir System B								
Benefits	121,000	121,000	259,000	259,000	185,000	185,000	207,000	207,000
Benefit:Cost Ratio	1.9	2.4	1.8	2.3	1.9	2.4	1.8	2.2
9-Reservoir System								
Benefits	125,000	125,000	262,000	262,000	172,000	172,000	185,000	185,000
Benefit:Cost Ratio	1.9	2.4	1.9	2.3	1.8	2.2	1.6	2.0

OTHER RESERVOIRS STUDIED

	Scovill Dam and Reservoir		Meadow Pond Brook Dam and Reservoir		Bladens River Dam and Reservoir		Little River Dam and Reservoir	
	50-Year	100-Year	50-Year	100-Year	50-Year	100-Year	50-Year	100-Year
	$	$	$	$	$	$	$	$
First Costs	3,476,000	3,476,000	1,890,000	1,890,000	4,108,000	4,108,000	2,752,000	2,752,000
Annual Charges								
Interest	89,100	89,100	48,400	48,400	105,000	105,000	70,500	70,500
Amortization	35,600	8,100	18,800	4,200	41,000	9,300	28,800	6,500
Maintenance	9,500	9,500	10,000	10,000	10,000	10,000	10,000	10,000
Interim replacements	500	600						
Net loss of taxes	7,000	7,000	3,500	3,500	18,500	18,500	500	500
Total Annual Charges	141,700	114,300	80,700	66,100	174,500	142,800	109,800	87,500
Annual Benefits(1)								
7-Reservoir System								
Benefits	-	-	-	-	64,000(2)	64,000(2)	78,000(2)	78,000(2)
Benefit:Cost Ratio	-	-	-	-	0.4	0.5	0.7	0.9
8-Reservoir System A								
Benefits	-	-	100,000	100,000	-	-	-	-
Benefit:Cost Ratio	-	-	1.2	1.5	-	-	-	-
8-Reservoir System B								
Benefits	122,000	122,000	-	-	-	-	-	-
Benefit:Cost Ratio	0.9	1.1	-	-	-	-	-	-
9-Reservoir System								
Benefits	114,000	114,000	102,000	102,000	-	-	-	-
Benefit:Cost Ratio	0.8	1.0	1.3	1.5	-	-	-	-

(1)Benefits based on respective flood control effectiveness of each reservoir in system without priority, after authorized projects.

(2)Benefits acting alone after authorized projects.

TABLE 2

COMPARATIVE FLOOD MAGNITUDES
FLOODS OF DECEMBER 1948, AUGUST AND OCTOBER 1955
AND STANDARD PROJECT FLOOD

LOCATION	DRAINAGE AREA (Sq.Miles)	STAGE IN FEET				PEAK DISCHARGE IN C.F.S.			
		Dec 1948	Aug 1955	Oct 1955	S.P.F.	Dec 1948	Aug 1955	Oct 1955	S.P.F.
Naugatuck River									
Torrington	48	14.0	22.0	10.0	25.5	7,500	25,000	3,500	35,000
Thomaston	96	12.0	24.0	9.5	27.5	14,100	53,000	10,000	68,500
Waterbury (above Mad River)	182	15.0	28.5	14.2	31.5	21,600	90,000	20,000	107,000
Waterbury (below Mad River)	209	15.0	27.3	14.0	30.5	24,500	97,000	24,000	121,000
Naugatuck	246	12.5	26.0	14.0	30.5	28,500	106,000	30,400	138,000
Ansonia	311	17.0	26.0	18.5	29.5	32,700	112,000	40,000	148,000

SECTION X - EXTENT AND CHARACTER OF FLOODED AREA

22. GENERAL

Large areas in the densely populated industrial communities located along the narrow flood plain of the lower Naugatuck River are involved in flooding. The lower Naugatuck River watershed in western Connecticut, with a long history of industrial development, constitutes one of the primary industrial areas in the United States. Several important industrial centers lie along both banks of the lower Naugatuck River and have significant portions of their urban and industrial districts located immediately along the main stream. Waterbury, with nearly 60 percent of the lower watershed population, Ansonia, and Naugatuck are the largest of these flood-prone communities.

The principal industrial activities in the lower Naugatuck River Basin are the manufacture of brass, bronze, heavy machinery, clocks, watches, rubber products, industrial chemicals, and a wide variety of fabricated metal products. The Naugatuck Valley comprises the leading non-ferrous metal manufacturing area in the nation. Over one-third of the nation's brass and bronze is produced in this area. The manufacture of copper, aluminum, and zinc products, and heavy machinery production are key contributions to the national economy.

23. WATERBURY, CONNECTICUT

The city of Waterbury, the largest community in the watershed, is situated along both banks of the Naugatuck River. Urban-industrial encroachment upon the Naugatuck and several smaller streams has intensified the Waterbury flood problem. More than 380 dwellings, 610 commercial establishments, and 10 public buildings are located in the flood-prone area in Waterbury. The central area, bounded by West Main Street, South Main Street, the Mad River, and the left bank of the Naugatuck River, contains the majority of these properties. A second area vulnerable to heavy flooding is the Riverside Street area along the right bank of the Naugatuck River between Freight and Washington Street bridges.

Flooding of industrial plants is a major problem in the Waterbury area. Approximately 46 industrial firms are subject to flooding by the Naugatuck River. Many of these firms are of major national importance, with several firms having widespread plants located adjacent to the main stream. During 1955 these firms employed nearly 60 percent of Waterbury's industrial workers. The 2 largest firms in the city vulnerable to flooding are the American Brass Company and the Chase Brass and Copper Company. In the reach between the West Main Street bridge and the Mad River confluence, 2 groups of large mills of the Waterbury division of the American Brass Company, a subsidiary of the Anaconda Copper Company, are vulnerable to flooding by the Naugatuck River. The Chase Brass subsidiary of the Kennecott Copper Company is also subject to flooding in its series of large mills located on the left bank of the Naugatuck a short distance downstream from the Thomaston town line.

24. ANSONIA, CONNECTICUT

Extensive areas along both banks of the Naugatuck River are vulnerable to flooding in Ansonia, the second largest city in the lower watershed. Nearly 150 dwellings, 270 commercial establishments and some 6 public buildings are subject to flooding. Over half of these properties lie in the reach between the Maple Street bridge and the mouth of Beaver Brook.

Six of the 13 industrial firms in Ansonia are located in the Naugatuck River flood area. During 1955 these 6 firms employed over 90 percent of the industrial workers in the Ansonia area. The Ansonia divisions of the American Brass Company and the Farrel-Birmingham Company, the 2 largest firms in the city, operate large plants on the left bank in the vicinity of the Maple Street bridge. A third large firm vulnerable to flooding is the Hershey Metal Products Corporation on the right bank near the Division Street bridge.

25. NAUGATUCK, CONNECTICUT

The third largest community in the lower watershed area, Naugatuck, is located on both banks of the Naugatuck River a short distance downstream of the mouth of Hop Brook. Approximately 120 residential properties and 110 commercial establishments are located in the flood plain, with the greatest concentration in the vicinity of the Maple Street bridge.

Ten of Naugatuck's 21 industrial plants are exposed to flooding. In 1955 these 10 plants employed about 8,600 workers, or nearly 85 percent of the industrial labor force employed in Naugatuck. The U. S. Rubber Company, by far the largest employer in the borough, operates major footwear and industrial chemical plants in lowland areas subject to damaging flooding.

SECTION XI - FLOOD DAMAGES

26. GENERAL

Downstream of the Thomaston Dam site, the Naugatuck River claimed 36 lives and caused an estimated loss of nearly $193,000,000 during the record flood of August 1955. Over 80 percent of this loss was experienced in Waterbury, Naugatuck, and Ansonia. Other hard-hit communities in this area were Thomaston, Seymour, and Beacon Falls.

Damage surveys conducted shortly after the flood indicated that over 2,200 buildings were damaged in the main damage zones of the lower Naugatuck Valley. Approximately 88 homes and apartment buildings, 47 commercial establishments, and 2 industrial plants were destroyed by floodwaters or floating debris. An additional 640 dwellings, 800 commercial structures, and 75 industrial firms experienced flooding at the first- or second-story levels. Supplemental surveys were conducted in 1956 along the principal tributaries affecting Waterbury, Naugatuck, and other downstream communities.

Loss of highway and bridge facilities and debris impacted against bridges were major hindrances in repairing severed gas, water, telephone, and electric services. Destruction of nearly 20 miles of track and 4 major trestles on the branch lines of the New York, New Haven and Hartford Railroad caused major transportation delays and hampered flood recovery operations. Table 3 shows the 1955 experienced flood losses in the main damage zones of the lower Naugatuck River Basin, tabulated by town and type of loss.

In the major flood of December 1948-January 1949, the previous maximum flood of record in the lower Naugatuck River Basin, losses along the main stream totaled over $1,600,000. Approximately $1,000,000 of this loss occurred in Waterbury and nearly $300,000 in the Ansonia area. The September 1938 flood, the previous maximum flood of record in the upper Naugatuck River Basin, caused an estimated loss of about $420,000 in the lower reaches of the Naugatuck River.

27. WATERBURY, CONNECTICUT

The Naugatuck River caused losses estimated at about $95,000,000 in the Waterbury area. Seventeen lives were lost when the Naugatuck River roared through the city and flooded more than 370 dwellings, 610 commercial establishments, 40 industrial firms, and 10 public buildings to depths up to 18 feet. Approximately 60 residential and commercial buildings were destroyed.

TABLE 3

AUGUST 1955 FLOOD LOSSES
LOWER NAUGATUCK RIVER, CONNECTICUT
(Losses in $1000)

Town	Urban	Industrial	Utility	Highway	Railroad	Total
Ansonia	$ 6,160.	$ 20,450.	$ 120.	$1,780.	$ 630.	$ 29,140.
Beacon Falls	1,850.	3,920.	-	420.	530.	6,720.
Naugatuck	6,770.	24,890.	120.	1,900.	530.	34,210.
Seymour	3,250.	6,950.	870.	1,220.	590.	12,880.
Thomaston	1,250.	11,190.	1,010.	890.	110.	14,450.
Waterbury	25,010.	63,470.	1,010.	1,760.	3,560.	94,810.
Watertown	290.	-	-	-	10.	300.
Total	44,580.	130,870.	3,130.	7,970.	5,960.	192,510.

Railroad, highway, and utility damages were severe in the Waterbury area, with rail losses totaling more than $3,500,000. Ponding behind a debris dam, which included the remains of an upstream railroad trestle, at the Bank Street bridge caused major flooding of several hundred residential, commercial, and industrial buildings in the heavily populated area on the left bank between Bank Street and the mouth of the Mad River. On the other bank, an entire row of tenements on Riverside Street, containing about 50 apartments, was swept away.

Damages sustained by 43 Waterbury industrial firms reached a staggering total of more than $63,000,000. Four of the 40 Waterbury plants with flooding above the basement level suffered large individual losses. Major losses were experienced in the upper Waterbury area when an 8-foot surge on the Naugatuck River smashed through the massive rolling and extrusion mills operated by the Chase Brass and Copper Company and buried the lower floors with debris. Like other metalworking firms in the valley, overhaul of motors and machinery was a major problem during the cleanup of 1 to 2 feet of silt in the main buildings.

Ponding behind the Bank Street bridge contributed to heavy flooding in plants operated by the American Brass Company and the Waterbury Farrel Foundry and Machine Company. Crippling damages were experienced by these plants when nearly 18 feet of water swept through the Waterbury Farrel Foundry rolling mills and 17 to 19 feet of water entered the extensive American Brass plants. Cleanup operations required many weeks of full-time reclamation work. The fourth firm with major flood losses, the Platt Brothers zinc mills in lower Waterbury, was partially leveled by converging flows on the main stream and an abandoned canal. Washout of the Bristol Street bridge, just upstream of the plant, contributed to heavy destruction of the firm's rolling mills.

28. NAUGATUCK, CONNECTICUT

Ten lives were lost in Naugatuck when the Naugatuck River overflowed its narrow channel and inundated the heart of the borough, causing a total loss of more than $34,000,000. Losses sustained by 10 Naugatuck industries totaled nearly $25,000,000. The U. S. Rubber Company, with 2 large chemical and footwear divisions located on the right bank of the Naugatuck near the Meadow Pond Brook confluence, suffered the major loss in the community as 7 to 9 feet of water roared through its widespread facilities. Rehabilitation of its plants, machinery, and equipment was a multimillion dollar task. Heavy industrial flooding was also experienced by several large metal and glass fabricators in the Bridge Street area near the mouth of Hop Brook. Major urban and highway damage was experienced along Connecticut Route 8, the Main Street area of Naugatuck, which parallels the river for its entire course through the town. Nearly 350 residential and commercial buildings in Naugatuck were damaged and some 40 of these were destroyed.

29. ANSONIA, CONNECTICUT

Flooded by the heavy flow on the Naugatuck River, Ansonia suffered losses of over $29,000,000. Two lives were lost as approximately 150 dwellings, 270 commercial establishments, and some 6 public buildings were flooded to depths up to 12 feet. Severe urban losses were experienced in the Main Street area when the Maple Street bridge washed away and the attendant surge released the mound of debris acting as a temporary dam. Damage to 5 Ansonia firms exceeded $20,000,000. Hardest hit were the Hershey Metal Products Corporation and the Ansonia divisions of the American Brass Company and the Farrel-Birmingham Company, with plants in the central part of the city. Located in low areas, these plants sustained heavy structural damage and heavy silting of machinery and finished products.

30. RECURRING LOSSES

Under economic conditions prevailing in 1958, a recurrence of the August 1955 flood after discharge reductions by Thomaston, Hall Meadow, and East Branch Reservoirs and the P.L. 685 project at Waterville-Waterbury would cause an estimated loss of $28,560,000 in the main damage zones of the lower Naugatuck River Basin. Approximately $9,350,000 of this loss would occur in the Waterbury area and nearly $11,000,000 in the Ansonia-Seymour area.

31. AVERAGE ANNUAL LOSSES

Average annual losses remaining in the lower Naugatuck River Basin after reductions by the above projects amount to $1,098,000.

(R 11/1/58)

SECTION XII - EXISTING CORPS OF ENGINEERS' FLOOD CONTROL PROJECTS

32. THOMASTON DAM AND RESERVOIR

This project was authorized by the Flood Control Act approved December 22, 1944 (Public Law 534, 78th Congress, 2d session). The site of the Thomaston Reservoir is on the Naugatuck River about 30 miles above its confluence with the Housatonic River and about 1½ miles north of Thomaston. The reservoir will extend upstream approximately 7 miles. The project provides for the construction of a rolled earth and rockfill dam 2,000 feet long at the crestline, rising 142 feet above the stream bed and providing a storage capacity of 42,000 acre-feet, equivalent to 8.1 inches of runoff from its tributary drainage area of 97.0 square miles. A side-channel spillway with a low concrete weir, constructed in rock, will be located in the left abutment of the dam. The outlet will consist of a 10-foot diameter concrete horseshoe conduit. Control will be accomplished by 2 hydraulically-operated slide gates. A contract for relocation of the railroad from the reservoir area was awarded in October 1957. A contract for construction of the dam was awarded in April 1958 with the project scheduled for completion in 1960. Estimated costs, as of the last printed Annual Report of the Chief of Engineers (1957), are $8,920,000 for construction and $8,580,000 for lands and damages, including highway, railroad, and utility relocations; a total of $17,500,000 for new work.

33. PUBLIC LAW 685 PROJECTS

Pursuant to the provisions of Section 205 of the Flood Control Act of 1948, as amended by Public Law 685, 84th Congress, 2d session, approved July 11, 1956, the Chief of Engineers has authorized studies of 5 local protection projects in the Naugatuck River Basin. These projects are described in the following paragraphs.

a. Torrington.

(1) East Branch and Naugatuck Rivers. This project consists of channel straightening, deepening, and widening, and construction of intermittent earth dikes and flood walls along the East Branch of the Naugatuck River and the main Naugatuck River below its confluence with the West Branch. Within the project length of approximately 9,000 feet, the new channel in the Naugatuck River has a bottom width of 130 feet; the channel in the East Branch has a bottom width of 50 feet from the confluence with the West Branch to the plant of the Connecticut Power Company, and a width of 30 feet for the remainder of the improvement. Dikes, composed of materials excavated from the channel, were constructed along portions of both banks of the improved channel. Several short sections of concrete retaining wall were constructed, together with minor repairs to

several existing masonry walls. The project is essentially complete. The estimated Federal first cost is $355,000.

(2) West Branch, Naugatuck River. This project provides for channel widening and deepening of the West Branch, Naugatuck River from Prospect Street to its confluence with the East Branch. Walls would be constructed on both banks of the river, in conjunction with bank and channel bottom protection. The estimated Federal first cost of this project is $374,000.

b. Waterbury.

(1) Naugatuck River. This project provides for the improvement of the Naugatuck River in the Waterville section of Waterbury in the vicinity of the Chase Brass Works and includes widening of the channel and construction of earth dikes, reinforced concrete flood walls, and a stoplog structure across the railroad. The channel of the Naugatuck River would be widened to a minimum bottom width of 200 feet for a distance of approximately 800 feet. An earth dike, approximately 180 feet long, would be constructed from the railroad to the highway on the left bank of the river. The highway, Connecticut Route 8, would be raised in lieu of constructing a stoplog structure at this point. A 20-foot stoplog structure would be provided at the railroad. An 80-foot length of reinforced concrete flood wall would be constructed downstream from the railroad bridge abutment to tie into an existing masonry wall. The total estimated Federal first cost of the project is $160,000. No construction has been started.

(2) Steel Brook. A project for the improvement of Steel Brook in the Oakville section of Waterbury is currently under study. The project would provide for channel improvement between the Main Street and Falls Avenue bridges, with possible improvement of the Main Street bridge. Benefits and costs for this project have not yet been determined.

c. Beacon Falls. This project involves widening and deepening the Naugatuck River channel for about 3,600 feet downstream from the Depot Street bridge. Boulders and cobbles excavated from the channel would be used as rockfill bank protection. No bridge or highway relocations are contemplated. Federal cost of this project is estimated at $150,000. Benefits from this project, with the reservoir system recommended in this report in operation, would be insufficient to justify the cost.

SECTION XIII - IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES

34. GENERAL

No projects for flood control in the Naugatuck River Basin have been constructed by other Federal or non-Federal agencies. Two proposals currently under consideration, which will have a beneficial effect on flood loss reduction, are described in the following 2 paragraphs.

35. ANSONIA, CONNECTICUT

The State of Connecticut, in its plans for a new Maple Street bridge over the Naugatuck River in Ansonia, is considering widening and deepening the river in this area. Removal of this hydraulic constriction will reduce flood heights in the Broad Street-Maple Street area currently under consideration for redevelopment.

36. RIVER ENCROACHMENT LINES

The State of Connecticut passed a river channel encroachment law during the 1955 session of its General Assembly. Section 9(c) of Public Act No. 364 (1957) directs the State Water Resources Commission to establish lines beyond which, in the direction of the waterways, no obstruction or encroachment shall be placed without approval of the Commission. On the Naugatuck River, these lines generally define the limits of a flood 7 times as large as the mean annual flood modified by the Thomaston Reservoir. Establishment of these lines along the Naugatuck River is substantially complete.

SECTION XIV - IMPROVEMENTS DESIRED

37. PUBLIC HEARING

In order to obtain the views of interested parties with respect to flood control and allied measures on the Naugatuck River and its tributaries, a public hearing was held in Waterbury, Conn., on December 11, 1956. Approximately 175 persons attended, including representatives of Federal, State, and municipal governments, industrial and agricultural interests, and civic organizations. Eight dam sites on tributaries of the Naugatuck River downstream of the Thomaston Dam, which were feasible from an engineering standpoint, were described. Improvements requested included flood control dams and reservoirs and various local improvements. Local opinion was about equally divided between a 6- and an 8-reservoir system for the Naugatuck River Basin.

a. Hall Meadow and East Branch Dams and Reservoirs. Representatives of the City of Torrington, the Naugatuck Valley River Control Commission, and an industrial plant reiterated their request for dams on the East and West Branches of the Naugatuck River upstream from Torrington. Twenty-nine local residents expressed opposition to the Hall Meadow Dam, while 4 others opposed both dams above Torrington. These 2 projects have been recommended in a previous report, printed as House Document No. 31, 85th Congress, 1st session.

b. Other dams and reservoirs. A representative of the Naugatuck Valley River Control Commission reiterated the Commission's approval of 6 of the 8 dam and reservoir sites being considered. Representatives of Waterbury, Torrington, Beacon Falls, and other municipal and industrial interests concurred. The 2 sites not considered favorably, pending further study, were those at Northfield Brook and Branch Brook. The mayor of Ansonia and many manufacturing firms indorsed all 8 sites. The then mayor of Naugatuck opposed construction of the Hop Brook and Meadow Pond Brook Dams. Opposition to the Hop Brook Dam was also expressed by the Town of Middlebury, 2 community organizations, and about 50 local property owners; while 4 other property owners opposed the Meadow Pond Brook Dam. Representatives of the Town of Thomaston were opposed to the Branch Brook project in Thomaston, while the first selectman of the Town of Plymouth expressed opposition to the proposed Hancock Brook Dam.

c. Local improvements. Several representatives of local governments and industrial plants asked for various local protective measures on the Naugatuck River at Waterbury, Beacon Falls, Seymour, Ansonia, and Derby.

SECTION XV - FLOOD PROBLEMS AND SOLUTIONS CONSIDERED

38. GENERAL

The Naugatuck River Basin is susceptible to floods caused by heavy rains or a combination of heavy rains and melting snow. Run-off is rapid due to generally hilly topography. Flooding has been aggravated by inadequate channels and restricted bridge openings. Much of the flood plain area is fully utilized by industrial and commercial developments as well as residential sections. The authorized Thomaston Reservoir will provide substantial protection for the affected communities. However, with this reservoir in operation, a recurring August 1955 flood would cause an estimated loss of $32,400,000 in the main damage zones of the lower Naugatuck River Basin.

Methods considered for solving the flood problems in the Naugatuck River Basin include reservoirs, to supplement the presently authorized project, and local improvement projects, consisting of dikes and flood walls with or without channel improvement. Restricting the use of the river flood channel, as a partial solution to the flood problem, is currently being put into effect by the State of Connecticut (see paragraph 46). Diversion of floodwaters is not feasible in the basin, nor is evacuation and resettlement, due to the high concentration of development in the flood plains.

39. RESERVOIRS

Owing to the extensive development in the area, there are no favorable reservoir sites on the main stem of the Naugatuck River other than the authorized Thomaston Dam. All tributary rivers were investigated for potential flood control dam sites. Three of the 12 tributaries studied, Beaver Brook, Hockanum Brook, and Falling Mill Brook, had drainage areas too small to warrant detailed investigation. All suitable sites on Steel Brook involved excessive damages. Detailed studies were made of the remaining 8 tributaries, Northfield Brook, Branch Brook, Hancock Brook, Mad River, Hop Brook, Meadow Pond Brook, Bladens River, and Little River. Economically justified sites were found on 4 tributaries, Northfield Brook, Branch Brook, Hancock Brook, and Hop Brook. Two alternative sites were investigated on Branch Brook, the Branch Brook site and the Black Rock site.

40. LOCAL PROTECTION

Local flood protection works, beyond those authorized for study under provisions of Public Law 685 (see paragraph 33), were considered for the various communities along the main stem and along Steel Brook in Watertown and Waterbury. These works would include dikes and flood walls and channel improvements. With the possible exception of local protection for Ansonia, none were found to be economically justified. Local protection for Ansonia is currently under study, the results of which will be included in a supplemental report.

41. RELATED WATER RESOURCE DEVELOPMENTS

None of the sites investigated for flood control were found feasible for multiple-purpose development.

SECTION XVI - FLOOD CONTROL PLANS

42. GENERAL

Studies made for this report indicate that, in addition to the authorized Thomaston Reservoir, flood control dams and reservoirs on 4 tributaries of the Naugatuck River are economically justified at this time. These projects are described in the following paragraphs.

a. Northfield Brook Dam and Reservoir. The Northfield Brook Dam would be located on Northfield Brook in the town of Thomaston, Conn. The dam site is approximately 1.3 miles above the mouth of Northfield Brook. The reservoir would be approximately $1\frac{1}{4}$ miles long and lie within the towns of Thomaston and Litchfield. At spillway crest elevation of 573 feet mean sea level, the reservoir would contain 2,430 acre-feet, equivalent to 8 inches of runoff from the 5.7 square mile drainage area. A reservoir map is shown on Plate No. 3 of this report.

The dam would be of rolled earth fill construction, with a length of 800 feet and a maximum height of 118 feet above the stream bed. A chute spillway, with an ogee weir, 70 feet long, would be founded on rock in the right abutment of the dam. The outlet works would consist of an ungated, 36-inch reinforced concrete conduit founded on rock on the right bank of the stream. A general plan and details of the dam and appurtenant structures are shown on Plate No. 4 of this report.

b. Black Rock Dam and Reservoir. The Black Rock Dam site is located on Branch Brook, approximately 1.8 miles above its mouth. The reservoir at the selected site would be approximately $1\frac{1}{2}$ miles long at spillway crest elevation 513. The reservoir would provide a flood control storage capacity of 8,860 acre-feet, equivalent to 8.0 inches of runoff from its tributary drainage area of 20.8 square miles. A reservoir map is shown on Plate No. 5 of this report.

The dam would be of rolled earth fill construction, with a length of 1,100 feet, and a maximum height of 153 feet. A side-channel spillway, with a length of 170 feet, would be located in the left abutment. A gated, 54-inch reinforced concrete conduit would provide control. A general plan and details of the dam are shown on Plate No. 6 of this report.

c. Branch Brook Dam and Reservoir. The Branch Brook Dam site is located on Branch Brook about 1 mile downstream from the Black Rock site described in subparagraph b above. Benefits to be realized by this project would be approximately the same as those attributable to the Black Rock Reservoir. Costs of this project, however, are substantially in excess of those for the Black Rock site and no further consideration was given this alternative.

d. Hancock Brook Dam and Reservoir. The Hancock Brook Dam would be located on Hancock Brook approximately 3 miles above its mouth. The reservoir, which would be located entirely within the town of Plymouth, would extend up Hancock Brook approximately 1½ miles and about 1.3 miles up Todd Hollow Brook, the principal tributary of Hancock Brook. At spillway crest elevation 484, the reservoir would provide 3,820 acre-feet of flood control storage, equivalent to 6.0 inches of runoff from the tributary drainage area of 12.0 square miles. A reservoir map is shown on Plate No. 7 of this report.

The dam would be of rockfill construction, with a length of 560 feet and a maximum height of 44 feet above the stream bed. A chute spillway with a concrete ogee weir, 145 feet long, would be located in the right abutment. An ungated, 48-inch reinforced concrete conduit would be located in the stream bed. A general plan and details of the dam are shown on Plate No. 8 of this report.

e. Hop Brook Dam and Reservoir. The Hop Brook Dam site is located on Hop Brook, approximately 1.3 miles above its mouth. The reservoir, about 1½ miles long, would be located in the towns of Middlebury and Waterbury. At spillway crest elevation 362, the reservoir would provide 6,840 acre-feet of storage, equivalent to 8.0 inches of runoff from the tributary drainage area of 16.0 square miles. A reservoir map is shown on Plate No. 9 of this report.

The dam would be of rolled earth fill construction, approximately 450 feet long, with a maximum height of 80 feet above the stream bed. A dike, approximately 275 feet long, with a maximum height of 12 feet, would close a saddle in the left abutment. A side-channel spillway with an ogee weir 200 feet long would be founded on rock in the left abutment. A gated, 48-inch reinforced concrete conduit would be located in the stream bed. A general plan and details of the dam are shown on Plate No. 10 of this report.

43. DEGREE OF PROTECTION

The proposed reservoir system would have sufficient capacity to control a recurrence of the March 1936, September 1938, December 1948, and October 1955 floods. The storage at all reservoirs, with the exception of Hop Brook, would be completely utilized and some spillway discharge would occur in a recurrence of the August

1955 flood. This spillway discharge would occur during the flood recession and hence would not increase flooding by synchronizing with the peak flows from the uncontrolled areas. The standard project flood would also produce some spillway discharge which likewise would not synchronize with uncontrolled flows. The standard project flood, as modified by the proposed reservoir system, was used as a basis for preliminary design of local protection projects. This represented a flood at Naugatuck with a peak about 40 percent greater than the maximum flood of record as modified.

Construction and operation of the authorized Thomaston Reservoir would reduce the stage of a recurring August 1955 flood by about 7 feet in Waterbury, a major damage center. Supplemental protection by the proposed reservoirs would reduce this flood stage by another 6 feet for a total reduction of 13 feet.

44. HYDROLOGIC AND HYDRAULIC CONSIDERATIONS

a. Analysis of floods. The major floods of March 1936, September 1938, December 1948, and August and October 1955 were analyzed in order to: (1) determine the discharge contributions of tributaries and local areas to flood flow at the principal damage centers, and (2) properly evaluate (a) the flood characteristics and potentialities of the various streams and (b) the necessity for reservoir control and/or local protection measures. The studies indicated that during floods the many short, steep tributaries of the Naugatuck River empty very quickly into the steep main channel. Any detention reservoir that would help desynchronize the flood flows would be of great value in preventing damage in the major communities downstream.

b. Typical tributary contribution flood. In order to evaluate the relative flood control effectiveness and the economics of projects, a synthetic flood was developed to represent a typical distribution of tributary flood contribution in the Naugatuck River Basin. The floods of record were used to determine the relative shape and timing of the flood hydrographs with the peak discharge and volumes related to frequency curves and average annual runoff.

c. Spillway and outlet capacities.

(1) Spillway capacities have been derived in accordance with established procedures, using the probable maximum precipitation centered over the watershed.

(2) Sizes of gated outlets were selected to satisfy the following criteria: (a) obtain outlet discharges equivalent to downstream safe channel capacity with a pool elevation corresponding to 20 percent of the reservoir storage; (b) permit emptying

the reservoir in a reasonable period of time, and (c) provide adequate diversion capacity during construction. The number and size of gates were selected to provide flexibility during all operating conditions and provide sufficient capacity to satisfy the preceding outlet criteria with 1 gate inoperative.

(3) Sizes of ungated outlets were based on the criteria of maintaining channel capacities with the pools at spillway crest.

45. RESERVOIR REGULATION

The operation of Northfield Brook and Hancock Brook Reservoirs, as well as the 2 previously recommended reservoirs above Torrington, will be automatic, since their outlets are ungated and the reservoirs will act as simple retarding basins. Operation of the Black Rock and Hop Brook Reservoirs would be coordinated with the operation of the authorized Thomaston Reservoir to provide protection to the downstream communities. This operation would be effected whenever flows were expected to exceed downstream channel capacities at damage centers.

46. PROVISIONS AGAINST ENCROACHMENT

The plans of the State of Connecticut for establishing channel encroachment lines along the Naugatuck River will limit future encroachment which would tend to decrease permissible reservoir outlet discharges and thereby increase the time required for emptying.

SECTION XVII - ESTIMATES OF FIRST COSTS AND ANNUAL CHARGES

47. GENERAL

First costs of the principal features and annual charges for the 4 proposed projects are presented in Tables 4 to 7. Since all 4 reservoirs will provide basinwide benefits, the estimates have been prepared on the basis that all costs would be borne by the Federal Government and that the Federal Government would maintain and operate the projects after completion. Maintenance and operation of the 4 reservoirs would be coordinated through the dam tender at Thomaston Reservoir. For this reason, and due to the proximity of suitable living quarters in the area, no provisions are made for operator's quarters at the dam sites. Small utility buildings for the storage of tools, minor equipment, and records are provided for each site.

Unit prices used in estimating construction and relocations costs are based on average bid prices for similar work in the same general area. The adopted unit prices are adjusted to 1958 price level and include minor items of work which do not appear in the cost estimates. Valuation of property is based on the Market Data Approach and reflects values in recent sales in the area.

All estimates include an allowance for contingencies. Costs of preauthorization studies are estimated on the basis of actual costs to date. Costs for engineering and design, and supervision and administration are based on knowledge of the sites and experience on similar projects.

Annual charges are based on an annual interest rate of 2.5 percent, with amortization of the project investment distributed over a 50-year period. Allowances are made for maintenance, operation, interim replacement of equipment having an estimated life of less than 50 years, and tax loss on lands removed from taxation.

TABLE 4

COST ESTIMATE
NORTHFIELD BROOK DAM AND RESERVOIR
(1958 Price Level)

First Costs		
Lands and damages	$ 150,000	
Relocations	287,000	
Reservoir	4,000	
Dam	870,000	
Buildings, grounds, and utilities	4,000	
Total direct cost	1,315,000	
Preauthorization studies	10,000	
Engineering and design	187,000	
Supervision and administration	108,000	
Total estimated first cost		$1,620,000
Federal Investment		
Total Federal first cost	1,620,000	
Interest during construction	40,000	
Gross Federal investment	1,660,000	
Salvage value of land	-19,000	
Net Federal investment	1,641,000	
Annual Charges		
Federal:		
Interest	41,500	
Amortization	16,800	
Maintenance and operation	5,000	
Total Federal annual charges	63,300	
Non-Federal:		
Estimated loss of taxes	1,000	
Total annual charges		64,300

TABLE 5

COST ESTIMATE
BLACK ROCK DAM AND RESERVOIR
(1958 Price Level)

First Costs		
Lands and damages	$ 428,000	
Relocations	583,000	
Reservoir	12,000	
Dam	1,913,000	
Access road	65,000	
Buildings, grounds, and utilities	4,000	
Total direct cost	3,005,000	
Preauthorization studies	10,000	
Engineering and design	305,000	
Supervision and administration	230,000	
Total estimated first cost		$3,550,000
Federal Investment		
Total Federal first cost	3,550,000	
Interest during construction	89,000	
Gross Federal investment	3,639,000	
Salvage value of land	-97,000	
Net Federal investment	3,542,000	
Annual Charges		
Federal:		
Interest	91,100	
Amortization	36,300	
Maintenance and operation	10,000	
Total Federal annual charges	137,400	
Non-Federal:		
Estimated loss of taxes	3,700	
Total annual charges		141,100

TABLE 6

COST ESTIMATE
HANCOCK BROOK DAM AND RESERVOIR
(1958 Price Level)

First Costs		
Lands and damages	$ 448,000	
Relocations	1,075,000	
Reservoir	38,000	
Dam	489,000	
Access road	76,000	
Buildings, grounds, and utilities	4,000	
Total direct cost	2,130,000	
Preauthorization studies	20,000	
Engineering and design	220,000	
Supervision and administration	150,000	
Total estimated first cost		$2,520,000
Federal Investment		
Total Federal first cost	2,520,000	
Interest during construction	63,000	
Gross Federal investment	2,583,000	
Salvage value of land	-66,000	
Net Federal investment	2,517,000	
Annual Charges		
Federal:		
Interest	64,600	
Amortization	25,800	
Maintenance and operation	5,000	
Total Federal annual charges	95,400	
Non-Federal:		
Estimated loss of taxes	2,800	
Total annual charges		98,200

TABLE 7

COST ESTIMATE
HOP BROOK DAM AND RESERVOIR
(1958 Price Level)

First Costs		
Lands and damages	$1,222,000	
Relocations	374,000	
Reservoir	17,000	
Dam	707,000	
Buildings, grounds, and utilities	4,000	
Total direct cost	2,324,000	
Preauthorization studies	20,000	
Engineering and design	155,000	
Supervision and administration	101,000	
Total estimated first cost		$2,600,000
Federal Investment		
Total Federal first cost	2,600,000	
Interest during construction	65,000	
Gross Federal investment	2,665,000	
Salvage value of land	-177,000	
Net Federal investment	2,488,000	
Annual Charges		
Federal:		
Interest	66,600	
Amortization	25,500	
Maintenance and operation	10,000	
Total Federal annual charges	102,100	
Non-Federal:		
Estimated loss of taxes	11,100	
Total annual charges		113,200

(R 12/31/58)

SECTION XVIII - ANNUAL BENEFITS

48. FLOOD PREVENTION BENEFITS

Flood damage prevention benefits represent the difference between the average annual losses of $1,098,000 remaining in the lower Naugatuck River Basin after discharge reductions by Thomaston, Hall Meadow, and East Branch Reservoirs and the P. L. 685 project at Waterville-Waterbury, and the average annual losses remaining after addition of 4 reservoirs on Northfield, Branch, Hancock, and Hop Brooks. Flood damage prevention benefits accruing to the 4 reservoirs amount to $639,000. A summary of annual flood prevention benefits is presented below.

Average Annual Flood Prevention Benefits
(1958 prices)

Northfield Brook Dam and Reservoir	$120,000
Black Rock Dam and Reservoir	225,000
Hancock Brook Dam and Reservoir	153,000
Hop Brook Dam and Reservoir	141,000
Total Annual Benefits	639,000

In addition to the tangible flood damage prevention benefits, important intangible benefits would accrue to the 4 reservoir projects through the reduction of the threat to life and of the potential danger of disease from polluted floodwaters.

49. ENHANCEMENT BENEFITS

Flood discharge and consequent flood stage reductions by the reservoir system would encourage higher utilization of downstream lands and buildings. The degree and form of such higher utilization, however, is conjectural. No higher utilization or enhancement benefits have, therefore, been assigned to the reservoir system.

SECTION XIX - PROJECT FORMULATION AND ECONOMIC JUSTIFICATION

50. GENERAL

Benefits for each of the 9 reservoirs studied in detail were first determined for each reservoir acting alone. Benefits attributable to the authorized Thomaston Reservoir, the P. L. 685 project at Waterville-Waterbury, and the previously recommended Hall Meadow Brook and East Branch Reservoirs were considered to be already realized and were, therefore, not eligible for redistribution among any of the projects under study. An analysis on this basis indicated 4 of the 9 projects under study had benefit-cost ratios of less than unity. Since this was the most favorable basis of consideration, these 4 projects were dropped from further study. Two projects on Branch Brook, the Black Rock project and the Branch Brook project, were alternatives having the same benefits. Since costs were substantially less for Black Rock than for Branch Brook, this latter site was dropped from further consideration. Benefits to each of the 4 remaining reservoirs in the system, based on respective flood control effectiveness, resulted in favorable benefit-cost ratios for all 4. As a final test of economic feasibility, benefits for each reservoir acting last in the system were determined. Under this stringent criteria, all 4 reservoirs had a benefit-cost ratio in excess of unity.

Table 8 gives pertinent data on the reservoirs in the proposed comprehensive plan and on other reservoirs studied.

TABLE 8

SUMMARY OF RESERVOIRS - NAUGATUCK RIVER BASIN

NAME	LOCATION: RIVER	LOCATION: TOWN	DRAINAGE AREA (Sq Miles)	FLOOD CONTROL CAPACITY (Acre-Ft)	FLOOD CONTROL CAPACITY (Inches)	FIRST COSTS: CONSTRUCTION $	FIRST COSTS: RELOCATIONS $	FIRST COSTS: LANDS $	FIRST COSTS: TOTAL $	ANNUAL CHARGES $	ANNUAL BENEFITS $	BENEFIT-COST RATIO
COMPREHENSIVE PLAN												
Hall Meadow(1) Brook	Hall Meadow Brook	Torrington	12.2	7,200	11.4	1,412,000	548,000	460,000(2)	2,420,000	100,000	244,000	2.44
East Branch(1)	E. Branch Naugatuck	Torrington	9.3	5,150	10.5	1,343,000	437,000	890,000(2)	2,670,000	102,000	128,000	1.25
Thomaston(3)	Naugatuck	Thomaston	97.0	42,000	8.1	8,920,000	6,784,000	1,796,000	17,500,000	674,000	3,058,000	4.54
Northfield Brook	Northfield Brook	Thomaston	5.7	2,430	8.0	1,108,000	362,000	150,000	1,620,000	64,300	120,000	1.87
Black Rock	Branch Br	Thomaston	20.8	8,860	8.0	2,415,000	707,000	428,000	3,550,000	141,100	225,000	1.59
Hancock Brook	Hancock Br	Plymouth	12.0	3,820	6.0	756,000	1,316,000	448,000	2,520,000	98,200	153,000	1.56
Hop Brook	Hop Brook	Middlebury	16.0	6,840	8.0	911,000	467,000	1,222,000	2,600,000	113,200	141,000	1.25
Totals						16,865,000	10,621,000	5,394,000	32,880,000	1,292,800	4,069,000	3.15
OTHER RESERVOIRS STUDIED												
Branch Brook(4)	Branch Br	Thomaston	22.8	10,000	8.4	2,135,000	787,000	1,716,000	4,638,000	203,500	225,000(5)	1.11
Scovill	Mad River	Wolcott	8.2	3,719	8.5	2,705,000	137,000	634,000	3,476,000	141,700	105,500(6)	0.74
Meadow Pond Brook	Meadow Pond Br	Naugatuck	6.5	2,090	6.0	921,000	364,000	605,000	1,890,000	80,700	66,900(6)	0.83
Bladens River	Bladens R	Seymour	10.0	6,000	11.25	2,030,000	848,000	1,230,000	4,108,000	174,500	25,800(6)	0.15
Little River	Little R	Oxford	12.20	4,620	7.1	1,389,000	698,000	665,000	2,752,000	109,800	35,100(6)	0.32

(1) Recommended in Interim Report, printed as H.Doc. 31, 85th Congress
(2) Local costs
(3) Under construction - costs from 1957 Annual Report
(4) Alternative to Black Rock
(5) Benefits acting in 7-reservoir system in place of Black Rock
(6) Benefits acting alone after reductions by Thomaston

(R 12/31/58)

SECTION XX - PROPOSED LOCAL COOPERATION

51. GENERAL

No local participation in the cost of any of the reservoirs under consideration is required since all projects will be operated solely for flood control and will provide basinwide benefits. However, local interests should be required to zone the channels downstream of the proposed dams to prevent encroachment which would be harmful or detrimental to reasonable, efficient reservoir operation. The State of Connecticut now has such a law and has established encroachment lines on the main stem of the Naugatuck River (see paragraph 36). Similar encroachment lines should be extended up the tributaries to the proposed dam sites.

SECTION XXI - COORDINATION WITH OTHER AGENCIES

52. GENERAL

Comments of Federal, State, and local agencies which reviewed the reservoir plans are summarized in the following paragraphs.

a. U. S. Bureau of Public Roads. The District Engineer of the U. S. Bureau of Public Roads notes that relocations of Federal-aid secondary routes would be required by construction of several of the projects. Details of the relocations will be coordinated with the Bureau and the Connecticut State Highway Department in the advanced planning stage.

b. U. S. Department of Health, Education, and Welfare. The Regional Engineer of the U. S. Department of Health, Education, and Welfare considers that the overall effects of the projects should be beneficial from a mosquito control standpoint. In commenting on vector problems related to the projects under study, he recommends that:

(1) The reservoir sites be cleared of trees and brush.

(2) Borrow pits be located, if possible, where they will be permanently inundated.

(3) Drainage ditches be provided for the elimination of seepage areas and similar types of ponded water.

(4) Flotage, secondary growth, and/or aquatic plants be removed as necessary after impoundment.

(5) Provisions be made in the maintenance program for regular and frequent field surveys to determine the amount of mosquito breeding.

(6) Provisions be made for chemical measures to control excessive production of mosquitoes, especially during periods of high flood crests.

c. U. S. Fish and Wildlife Service. The Regional Engineer of the U. S. Fish and Wildlife Service indicates that the overall effects of the 4 proposed projects on fish and wildlife are not severely adverse and that opportunities for realistic mitigation of fish and wildlife losses appear limited. He recommends establishment of small permanent pools at the Northfield Brook and Hop Brook Dams and subimpoundments in the Hancock Brook and Hop Brook Reservoir areas. The Connecticut State Board of Fisheries and Game endorses the statements of the Federal Fish and Wildlife Service.

d. Federal Power Commission. The Regional Engineer of the Federal Power Commission concludes that no modifications for the purpose of power development are warranted.

e. National Park Service. The Regional Archaeologist of the National Park Service considers that it is probable that archaeological salvage may be involved at the proposed sites, but that definite information as to the presence of historic or prehistoric values must await surveys which, heretofore, have been made only in reservoir areas of authorized projects.

f. Connecticut Water Resources Commission. The Connecticut Water Resources Commission, the officially designated representative of the Governor on water policy matters in the State, concurs in the findings of the Division Engineer.

g. Naugatuck Valley River Control Commission. The Naugatuck Valley River Control Commission, appointed by the Governor, under statutory authority, to study the problems of flood control in the Naugatuck River Valley, to cooperate with and correlate its efforts with Federal and State agencies, and make recommendations to the Governor and the Connecticut General Assembly, also concurs in the findings of the Division Engineer.

SECTION XXII - DISCUSSION

53. FLOOD PROBLEMS

Additional flood protection for the Naugatuck River Basin is urgently needed. Numerous industrial and commercial establishments and residential developments located on the flood plains have suffered widespread damage in 6 major floods in the past 30 years, resulting in serious disruption of the basin economy. With the completion of the authorized Thomaston Reservoir and the construction of the 2 recommended reservoirs above Torrington, a recurrence of the August 1955 flood would still produce losses of $32,400,000 in the lower Naugatuck River Valley.

54. RELATED WATER RESOURCE DEVELOPMENTS

Hydroelectric power, water supply, and pollution abatement are among the related water resource developments considered for the Naugatuck River Basin. No reservoir sites were found where such facilities could be economically developed in connection with flood control inasmuch as multiple-purpose developments would involve excessive costs for lands and relocations.

The District Engineer of the U. S. Bureau of Public Roads commented that alternative road relocations necessitated by the proposed reservoirs should be investigated. The relocations shown in this report are adequate replacements in kind for the existing facilities. Any improvements or more costly relocations would have to be financed by other interests and would have no effect on the economics of the proposed projects. Minor modification to the plans considered for this report would be accomplished during the design phase of the projects.

Consideration has been given to the recommendations of the U.S. Public Health Service, Department of Health, Education, and Welfare. In accordance with present policy, land acquisition would be in fee only to the limit of 5-year flooding, with reservoir clearing to the height of the winter operational pool. The entire reservoir area would, therefore, not be cleared as requested. Borrow pits will be located insofar as possible within the reservoir limits to minimize the cost of required land acquisition. However, since the reservoirs will be operated for flood control only and hence will normally be empty, permanent inundation of the borrow pits is not contemplated. Borrow pits will, however, be so graded as to eliminate ponding areas in which mosquitoes breed. Under normal operational procedures, flotage and dead and down timber is removed from reservoir areas after each impoundment. However, neither funds nor technical personnel would be available to make the recommended regular and frequent field surveys to determine the amount of mosquito breeding nor for providing chemical measures to control excessive production of mosquitoes.

The Regional Director of the U. S. Fish and Wildlife Service, Department of the Interior, recommends small permanent pools at the Northfield Brook and Hop Brook Dams and subimpoundments in the Hancock Brook and Hop Brook Reservoirs. Creation of permanent pools at either dam would entail additional construction which, while relatively small in cost, has not been shown by the Fish and Wildlife Service to be economically justified in resulting benefits. The 2 recommended subimpoundments would be located in the upper reaches of the reservoirs on which only flowage easement would probably be obtained. Costs of such subimpoundments, including the cost of land acquisition in fee, would have to be borne by other interests. Such subimpoundments would have a negligible effect on the flood control effectiveness of the reservoirs, and there would be no objection to such construction.

The Naugatuck Valley River Control Commission, while concurring in the proposed projects, urges that "the door not be closed to further consideration of other protective projects." Consideration was given to local protective measures at damage centers throughout the basin and, on the basis of available information and present use, all were found to lack economic justification at this time. At Ansonia, consideration is being given to urban renewal of a portion of the city within the flood plan. Justification for local protection for this area, based on flood damage prevention and enhancement benefits, is currently under study, the results of which will be included in a supplemental report.

SECTION XXIII - CONCLUSIONS AND RECOMMENDATIONS

55. CONCLUSIONS

Periodic flood discharges produce major damages in the highly industrialized Naugatuck River Basin. The area will continue to face this threat after completion of the authorized Thomaston Reservoir.

Additional protection can be provided by construction of flood control reservoirs on tributaries of the Naugatuck River. The proposed plan of reservoirs would afford a high degree of protection and is economically justified. Local protection projects in lieu of or in addition to the proposed plan are not economically justified at this time, with the possible exception of small projects being or to be considered under authority of Public Law 205 of the 1948 Flood Control Act as amended by Public Law 685, 84th Congress, and local protection at Ansonia. A supplemental report will be prepared on Ansonia.

Multiple-purpose use of any of the proposed projects is not economically justified at this time.

56. RECOMMENDATIONS

It is recommended that the plan for the control of floods in the Naugatuck River Basin, approved by the 1944 Flood Control Act (Public Law 534, 78th Congress), be modified to provide for the construction of flood control dams and reservoirs on Northfield Brook, Branch Brook, Hancock Brook, and Hop Brook, all substantially in accordance with plans described in this report, at a total estimated first cost to the United States of $10,230,000 exclusive of preauthorization costs, and annual costs of $30,000 for maintenance and operation, providing local interests establish encroachment lines downstream of the dams to permit reasonable, efficient reservoir operation.

Att.
10 Report Plates
6 Appendices

ALDEN K. SIBLEY
Brigadier General, U. S. Army
Division Engineer

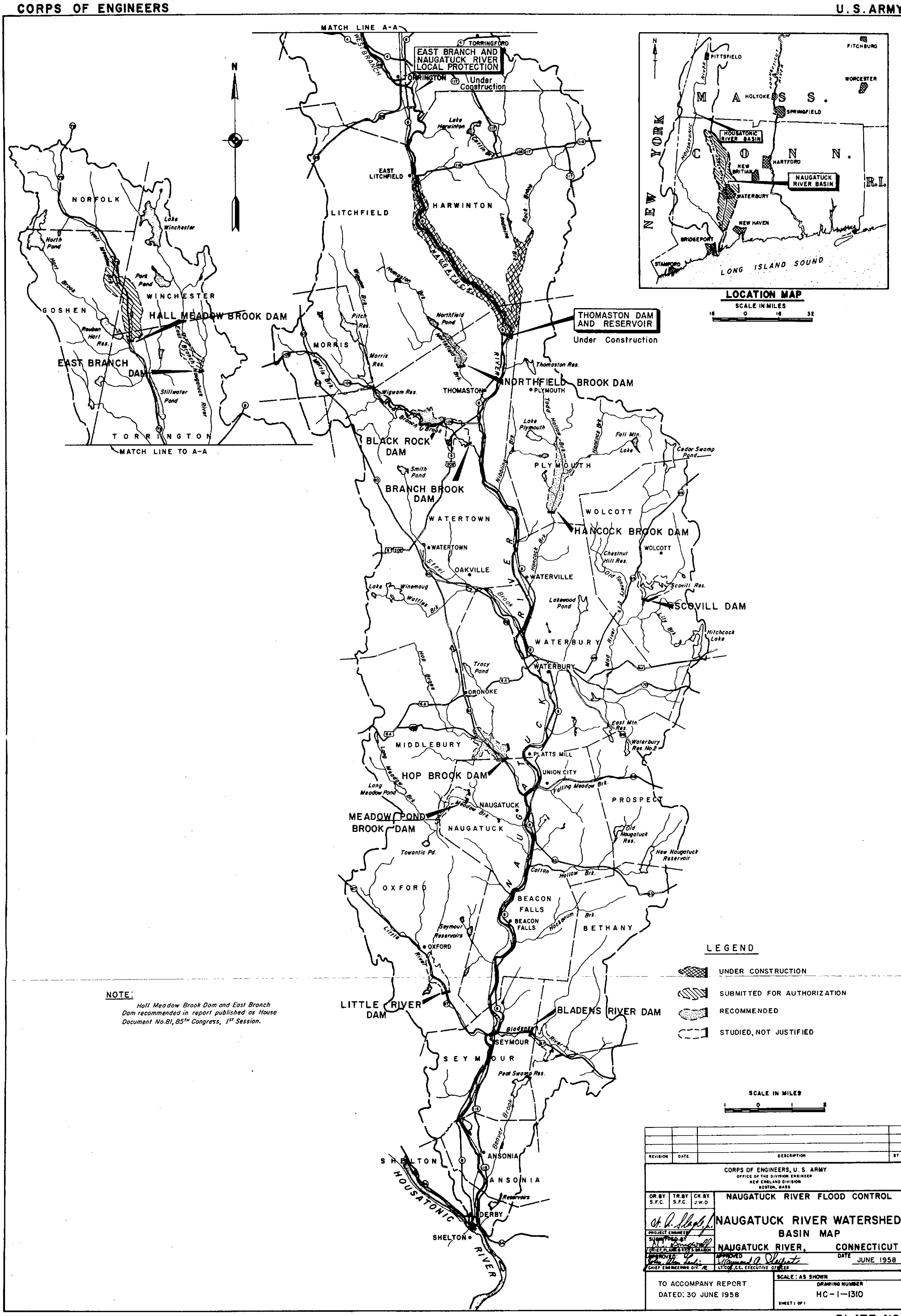
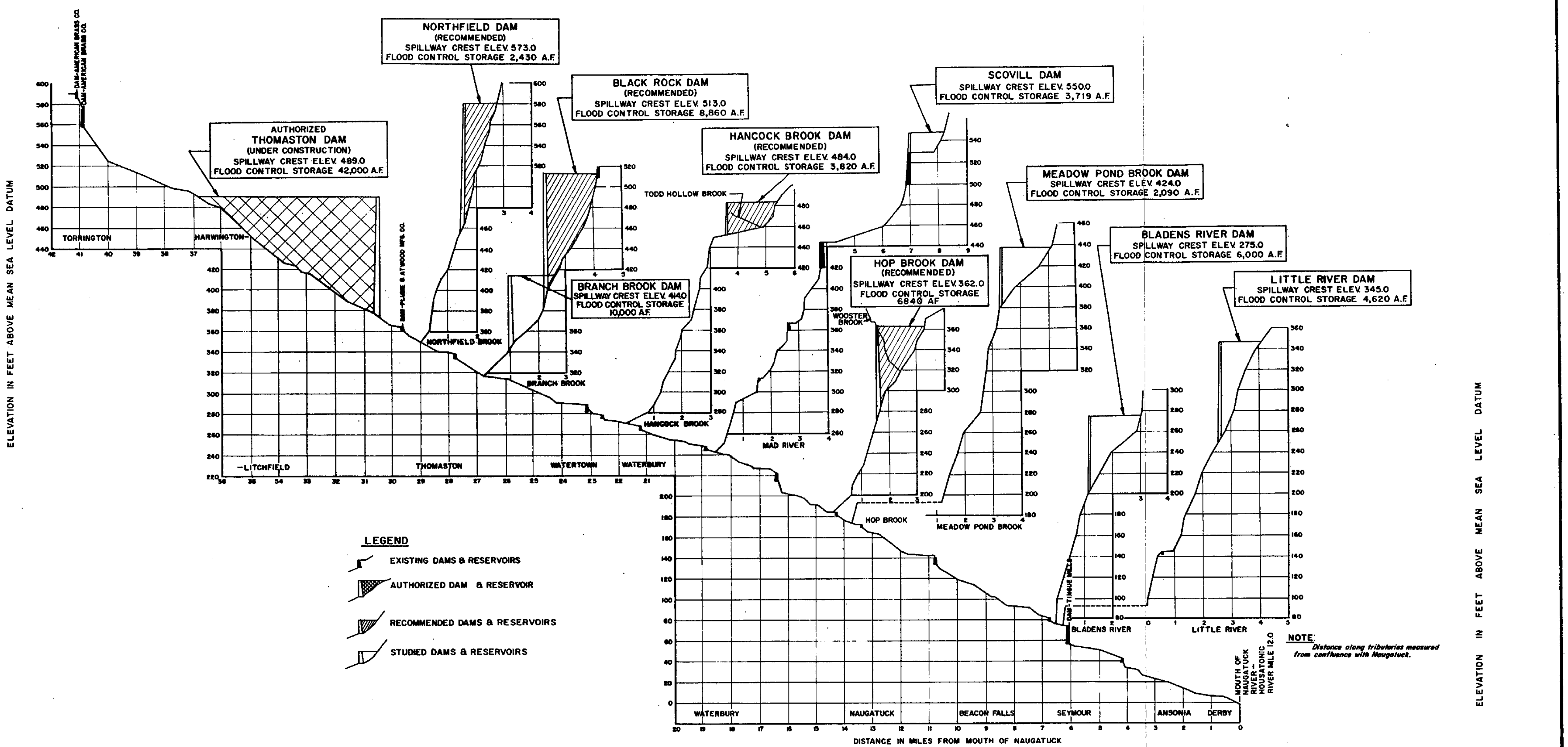

MATCH LINE A-A
EAST BRANCH AND NAUGATUCK RIVER LOCAL PROTECTION
Under Construction
TORRINGFORD
TORRINGTON
WEST BRANCH
Lake Harwinton
EAST LITCHFIELD
HARWINTON
LITCHFIELD
NAUGATUCK RIVER
THOMASTON DAM AND RESERVOIR
Under Construction
Northfield Pond
MORRIS
Morris Res.
Wigwam Res.
THOMASTON
NORTHFIELD BROOK DAM
Thomaston Res.
PLYMOUTH
BLACK ROCK DAM
BRANCH BROOK DAM
Smith Pond
Lake Plymouth
Fall Mtn. Lake
Cedar Swamp Pond
WOLCOTT
HANCOCK BROOK DAM
WATERTOWN
OAKVILLE
WATERVILLE
Chestnut Hill Res.
Scovill Res.
SCOVILL DAM
Lake Winnemaug
Lakewood Pond
Hitchcock Lake
WATERBURY
Tracy Pond
ORONOKE
East Mtn. Res.
Waterbury Res. No.2
MIDDLEBURY
PLATTS MILL
UNION CITY
HOP BROOK DAM
Long Meadow Pond
Falling Meadow Brk.
PROSPECT
MEADOW POND BROOK DAM
NAUGATUCK
Old Naugatuck Res.
New Naugatuck Reservoir
Towantic Pd.
OXFORD
BEACON FALLS
BETHANY
Seymour Reservoirs
LITTLE RIVER DAM
BLADENS RIVER DAM
SEYMOUR
Peat Swamp Res.
ANSONIA
SHELTON
DERBY
HOUSATONIC RIVER
NORFOLK
Lake Winchester
North Pond
Park Pond
GOSHEN
WINCHESTER
HALL MEADOW BROOK DAM
Reuben Hart Res.
EAST BRANCH DAM
Stillwater Pond
TORRINGTON
MATCH LINE TO A-A
NOTE: Hall Meadow Brook Dam and East Branch Dam recommended in report published as House Document No.81, 85TH Congress, 1ST Session.
PITTSFIELD
FITCHBURG
WORCESTER
MASS.
HOLYOKE
SPRINGFIELD
NEW YORK
HOUSATONIC RIVER BASIN
CONN.
HARTFORD
NEW BRITAIN
NAUGATUCK RIVER BASIN
R.I.
WATERBURY
NEW HAVEN
BRIDGEPORT
STAMFORD
LONG ISLAND SOUND
LOCATION MAP
SCALE IN MILES
16 0 16 32
LEGEND
UNDER CONSTRUCTION
SUBMITTED FOR AUTHORIZATION
RECOMMENDED
STUDIED, NOT JUSTIFIED
SCALE IN MILES
1 0 1 2
REVISION DATE DESCRIPTION BY
CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.
DR. BY S.F.C. TR. BY S.F.C. CK. BY J.W.O.
NAUGATUCK RIVER FLOOD CONTROL
NAUGATUCK RIVER WATERSHED
BASIN MAP
NAUGATUCK RIVER, CONNECTICUT
DATE JUNE 1958
TO ACCOMPANY REPORT
DATED: 30 JUNE 1958
SCALE: AS SHOWN
DRAWING NUMBER HC-1-1310
SHEET 1 OF 1

PLATE NO. I



REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY R.P.M. | TR. BY F.L.C. | CK. BY J.W.D.

PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLAN'G & RPTS BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
LT. COL., C.E. EXECUTIVE OFFICER

HOUSATONIC RIVER FLOOD CONTROL

PROFILES

NAUGATUCK RIVER & TRIBUTARIES

NAUGATUCK RIVER — CONNECTICUT

DATE JUNE 1958

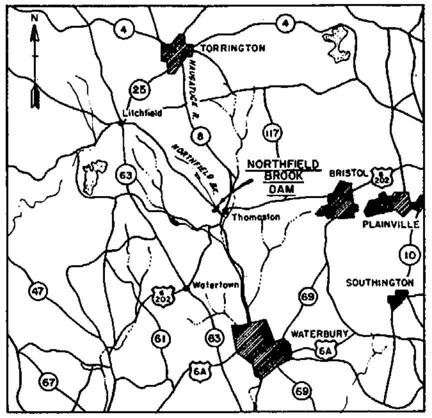
SCALE: AS SHOWN

TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

DRAWING NUMBER
HC-1-1311

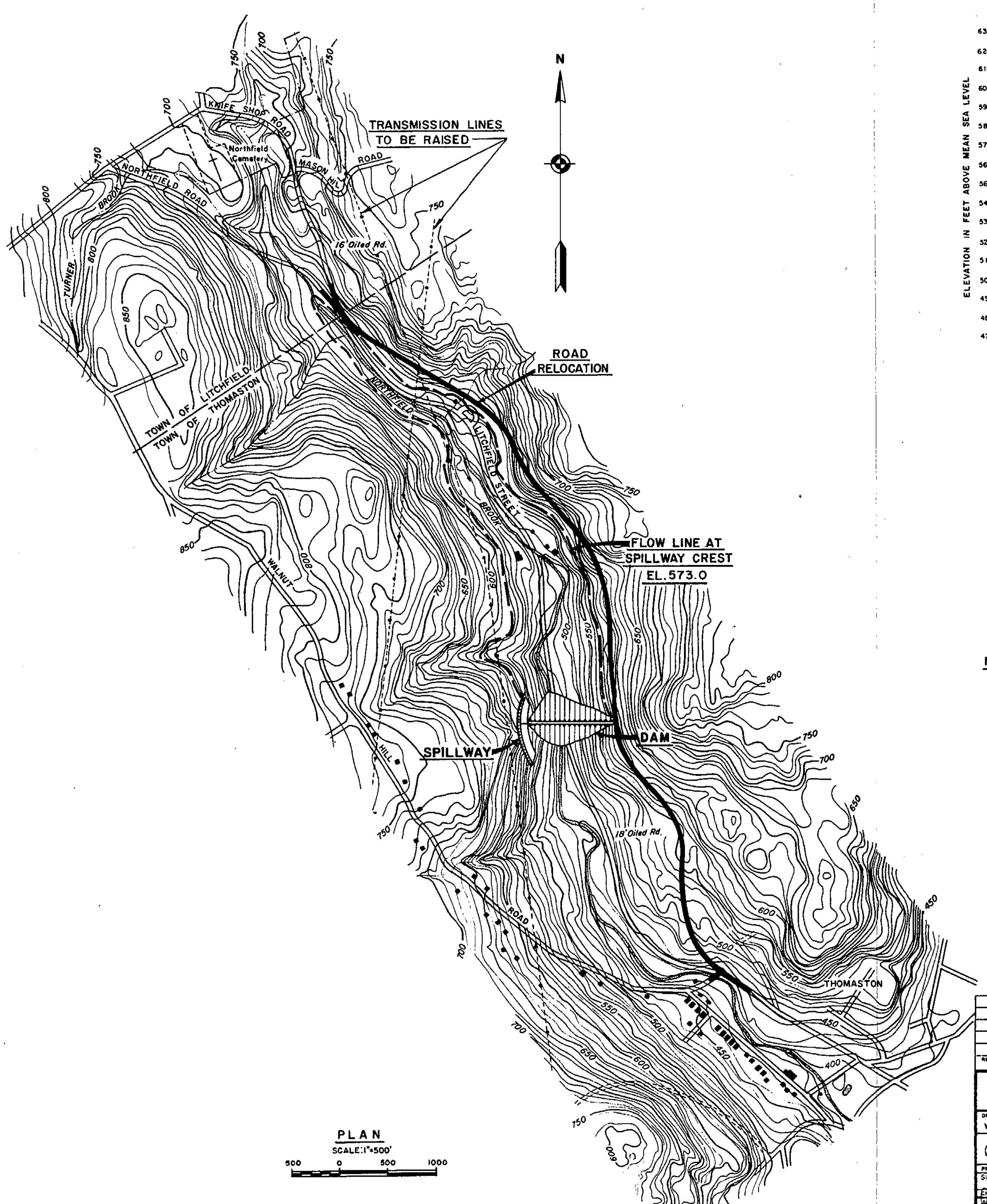
SHEET 1 OF 1

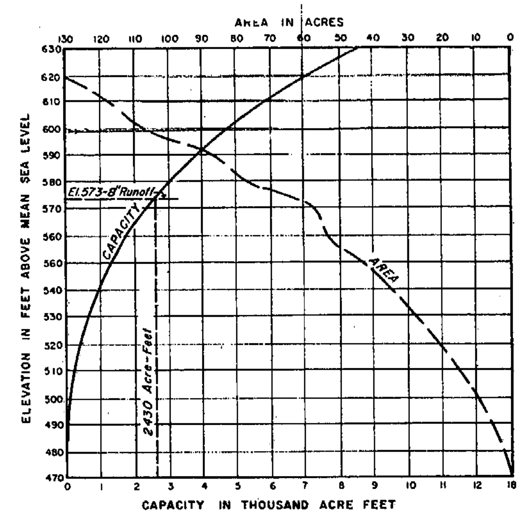
PLATE NO. 2



VICINITY MAP

SCALE IN MILES





AREA AND CAPACITY CURVES

(DAM) DRAINAGE AREA 5.69 SQ. MILES
(MOUTH) DRAINAGE AREA 6.50 SQ. MILES

NOTES:

Elevations refer to Mean Sea Level Datum.
Contour interval equals ten feet.
Topography is based on U.S.G.S. Map.

LEGEND

- EXISTING GRAVEL ROAD
- EXISTING PAVED ROAD
- ROAD RELOCATION
- TRANSMISSION LINE
- TOWN BOUNDARY
- RESERVOIR AT SPILLWAY CREST EL. 573.0

PLAN
SCALE: 1"=500'
500 0 500 1000

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY	TR. BY	CK. BY
W.N.	M.W.B.	J.W.D.

PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & REP'TS BRANCH
APPROVED:
CHIEF ENGINEERING DIV.

HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK
RESERVOIR MAP
NAUGATUCK RIVER CONNECTICUT

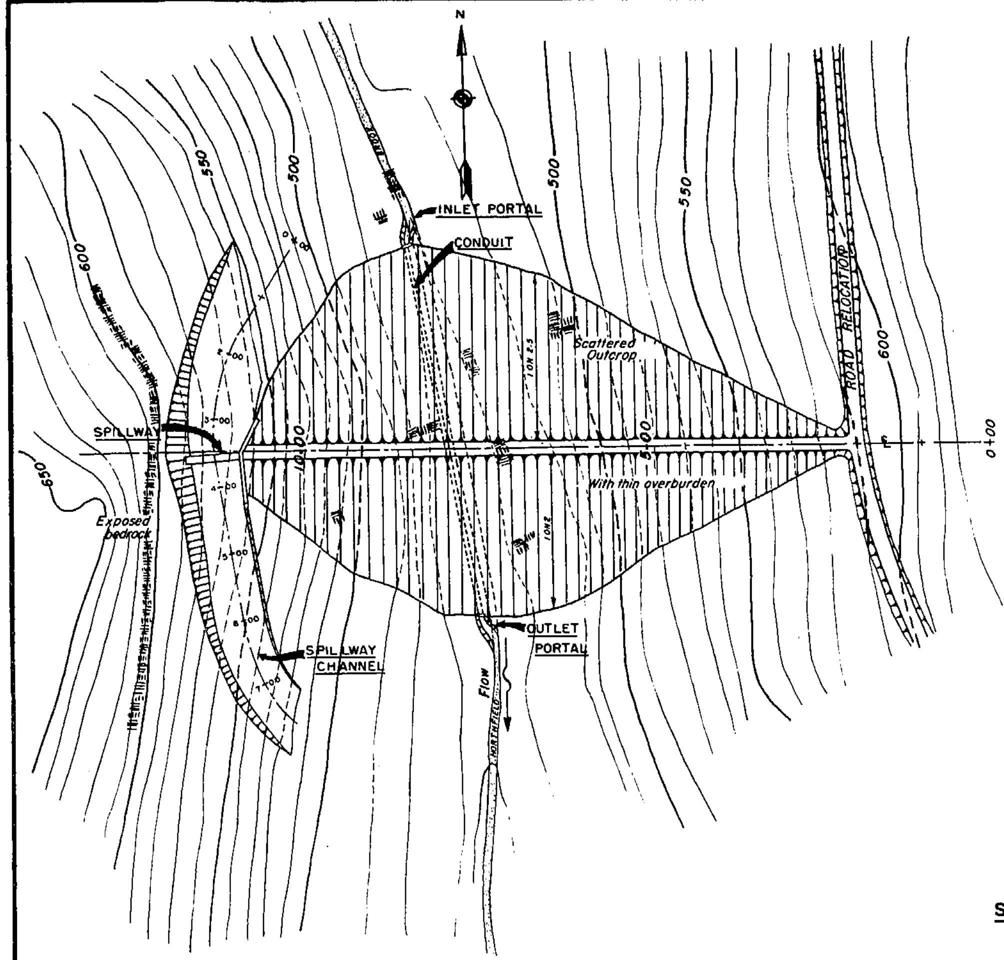
APPROVED
LT. COL., C.E. EXECUTIVE OFFICER

DATE JUNE 1958

TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

SCALE: AS SHOWN
DRAWING NUMBER
HC—I—1312
SHEET 1 OF 1

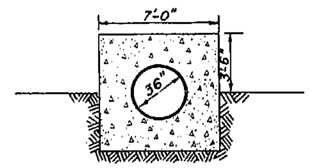
PLATE NO. 3



GENERAL PLAN

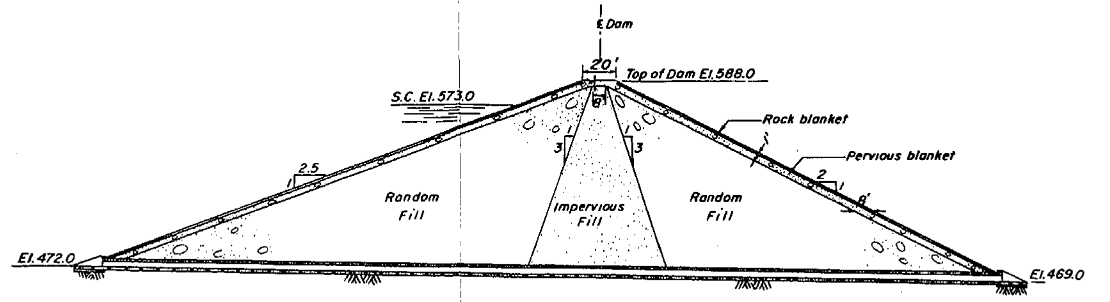
SCALE IN FEET

100' 0' 100' 200'



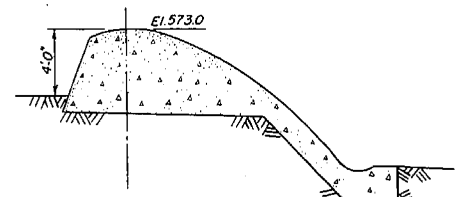
TYPICAL CONDUIT SECTION

SCALE: $\frac{1}{4}$"=1'-0"



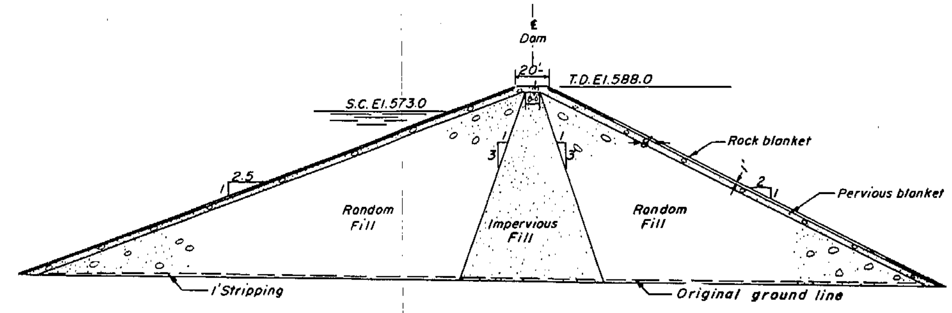
PROFILE ALONG ℄ OUTLET WORKS

SCALE: 1"=40'



SECTION THRU SPILLWAY WEIR

SCALE: $\frac{1}{4}$"=1'-0"

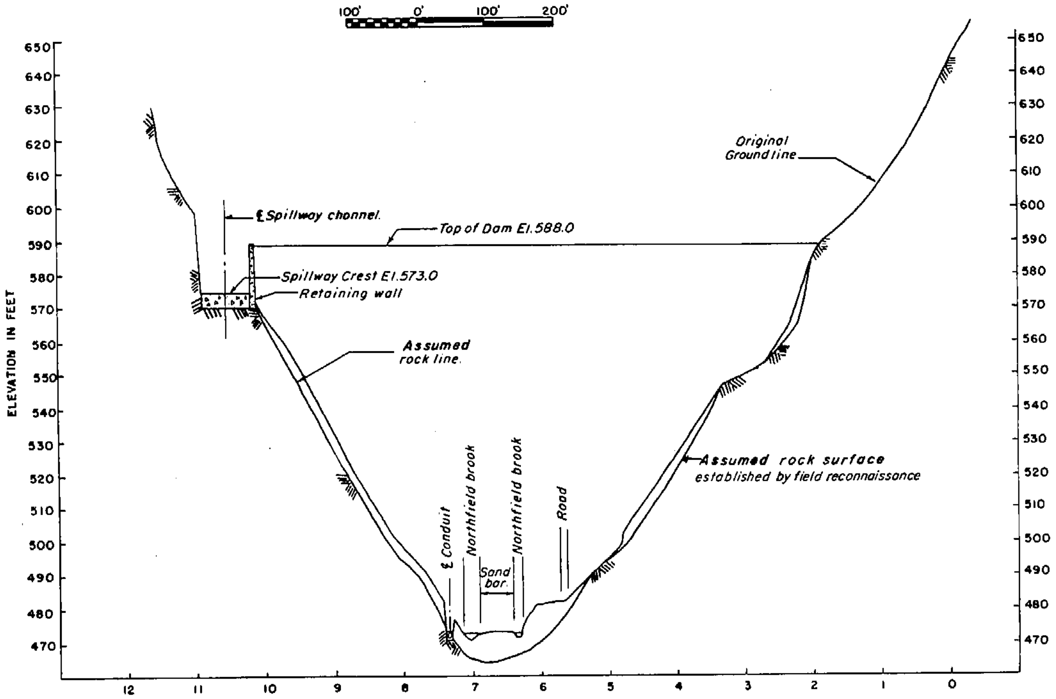


TYPICAL DAM SECTION

SCALE: 1"=40'

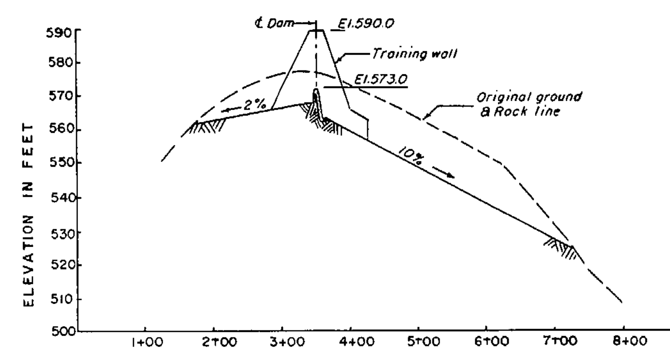
NOTES:

Topography based on U.S. Army Map Servicemap (1:25,000-1947).
Dam profile based on field survey.
Elevation refer to Mean Sea Level Datum.



PROFILE ALONG ℄ OF DAM

SCALE: HOR. 1"=100' VERT. 1"=20'



PROFILE ALONG ℄ SPILLWAY CHANNEL

SCALE: HOR. 1"=100' VERT. 1"=20'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY WN | TR. BY P.W.G. | CK. BY J.W.D.

HOUSATONIC RIVER FLOOD CONTROL

NORTHFIELD BROOK

GENERAL PLAN

NAUGATUCK RIVER CONNECTICUT

PROJECT ENGINEER — SUBMITTED BY — CHIEF, PLANN. & REP'S BRANCH — APPROVED — CHIEF, ENGINEERING DIV. — APPROVED — LT.COL., C.E. EXECUTIVE OFFICER

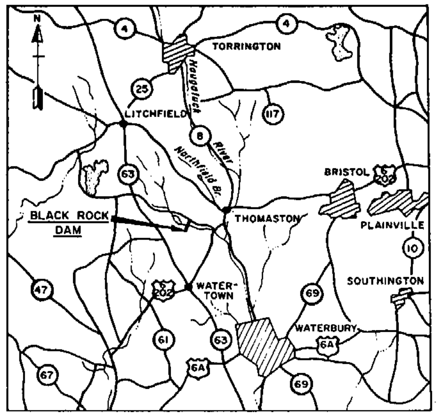
DATE JUNE 1958

SCALE: AS SHOWN

TO ACCOMPANY REPORT DATED: 30 JUNE 1958

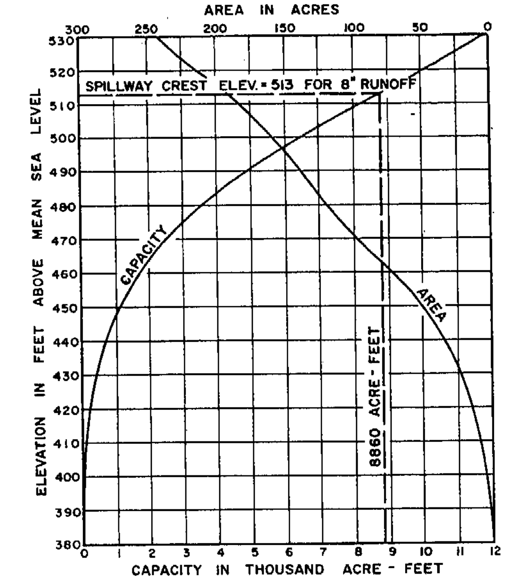
DRAWING NUMBER HC-1-1313

SHEET 1 OF 1



VICINITY MAP

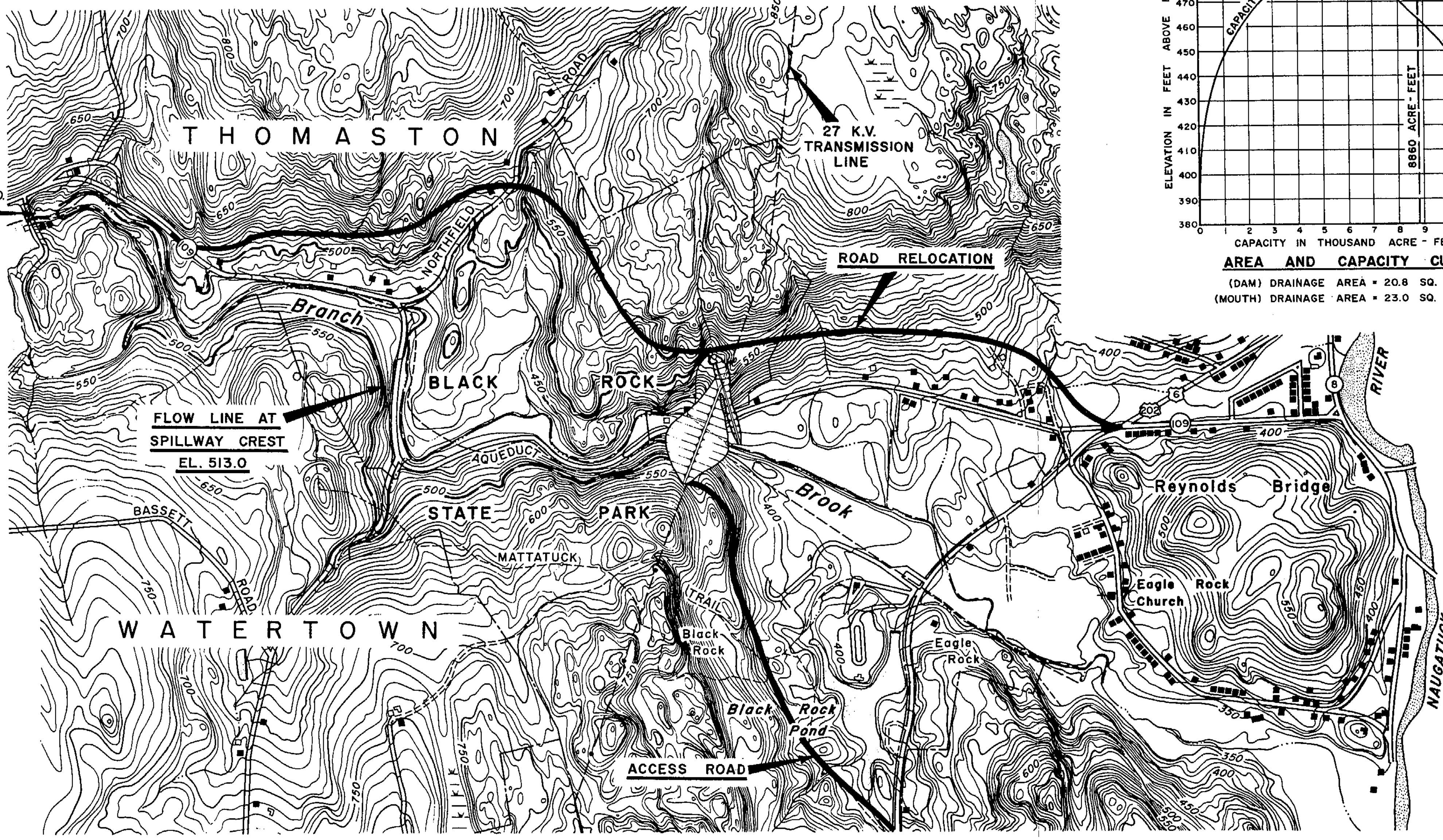
SCALE IN MILES



AREA AND CAPACITY CURVES

(DAM) DRAINAGE AREA = 20.8 SQ. MILES

(MOUTH) DRAINAGE AREA = 23.0 SQ. MILES



LEGEND

- EXISTING GRAVEL ROAD
- EXISTING PAVED ROAD
- ROAD RELOCATION
- TRANSMISSION LINE
- RESERVOIR AT SPILLWAY CREST EL. 513.0

PLAN

SCALE: 1" = 500'

NOTES

Elevations refer to Mean Sea Level Datum.

Contour interval equals ten feet.

Topography based on U.S.G.S. Map.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON MASS.

DR BY J.C.B. TR BY M.S. CK BY J.W.D.

HOUSATONIC RIVER FLOOD CONTROL

BLACK ROCK DAM

RESERVOIR MAP

NAUGATUCK RIVER CONNECTICUT

PROJECT ENGINEER
SUBMITTED BY
APPROVED CHIEF ENGINEERING DIV.
APPROVED LT. COL. C.E. EXECUTIVE OFFICER

DATE JUNE 1958

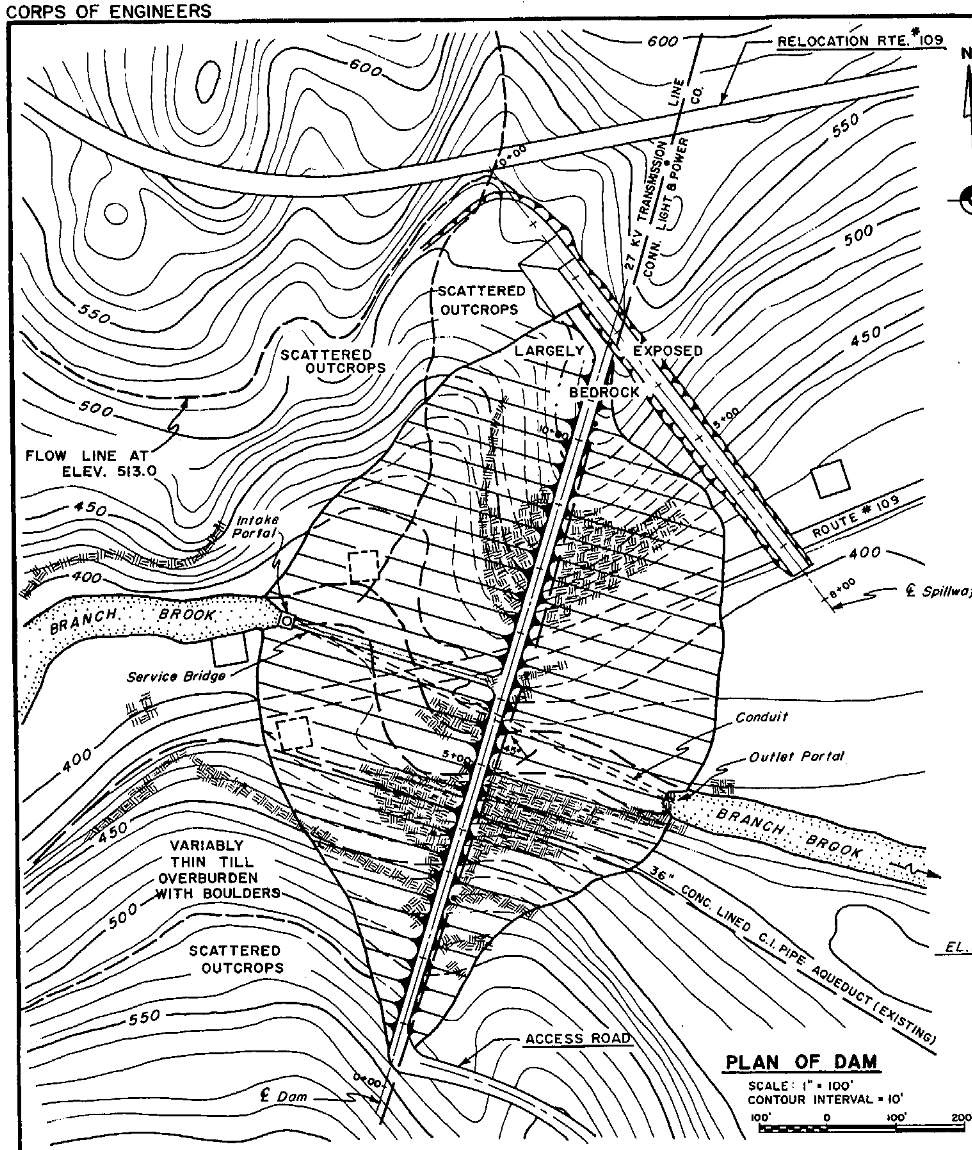
SCALE AS SHOWN

TO ACCOMPANY REPORT DATED: 30 JUNE 1958

DRAWING NUMBER HC-1-1314

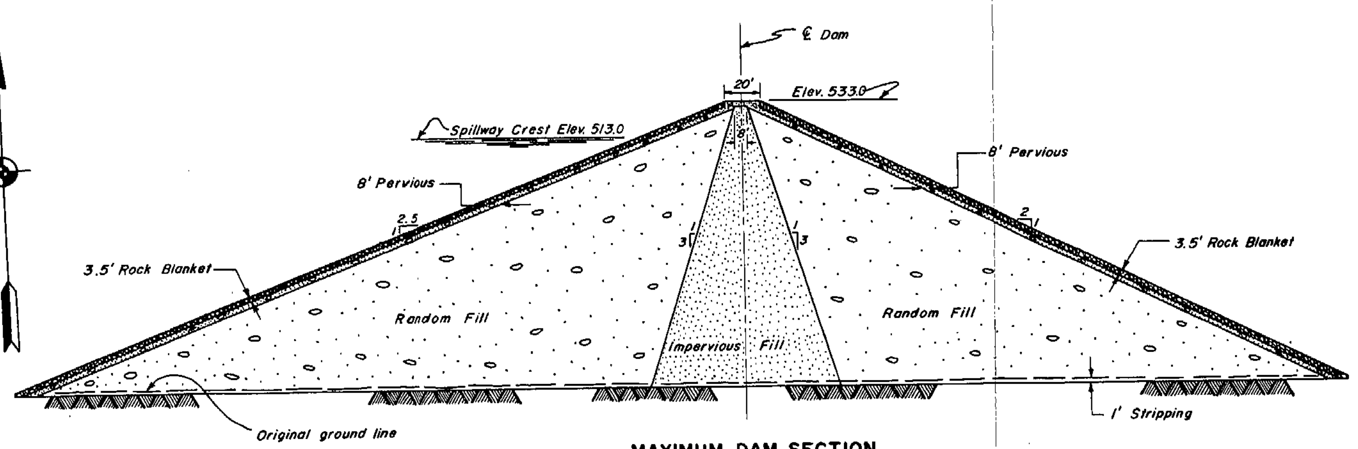
SHEET 1 OF 1

PLATE NO. 5



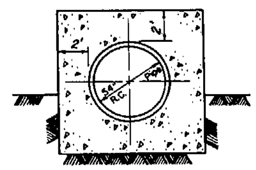
PLAN OF DAM

SCALE: 1" = 100'
CONTOUR INTERVAL = 10'



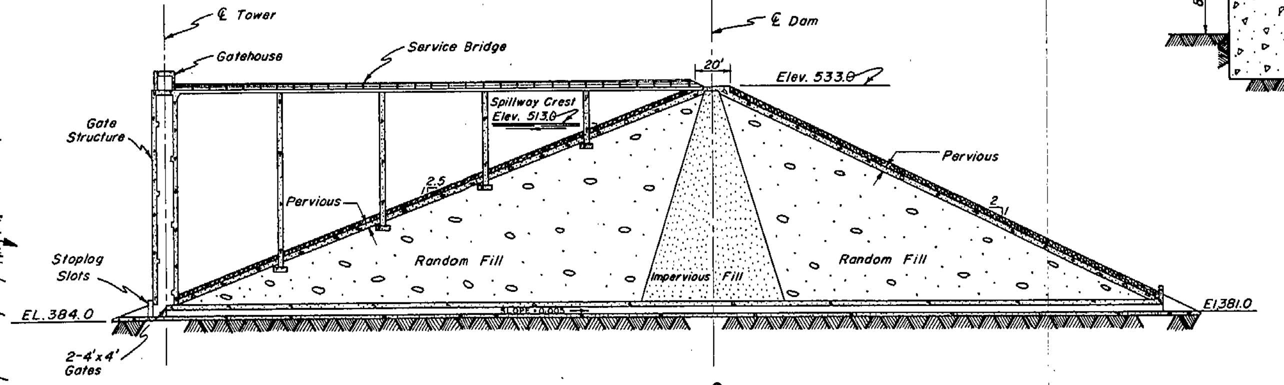
MAXIMUM DAM SECTION

SCALE: 1" = 40'



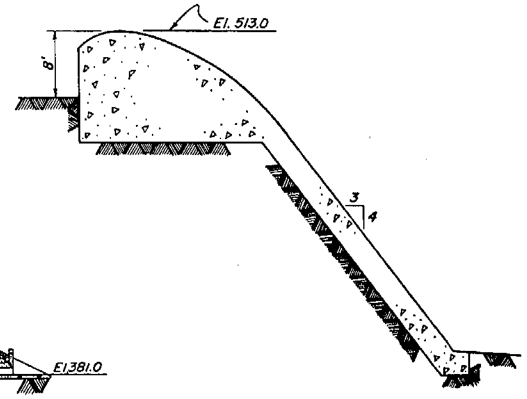
TYPICAL CONDUIT SECTION

SCALE: 1/4" = 1'-0"



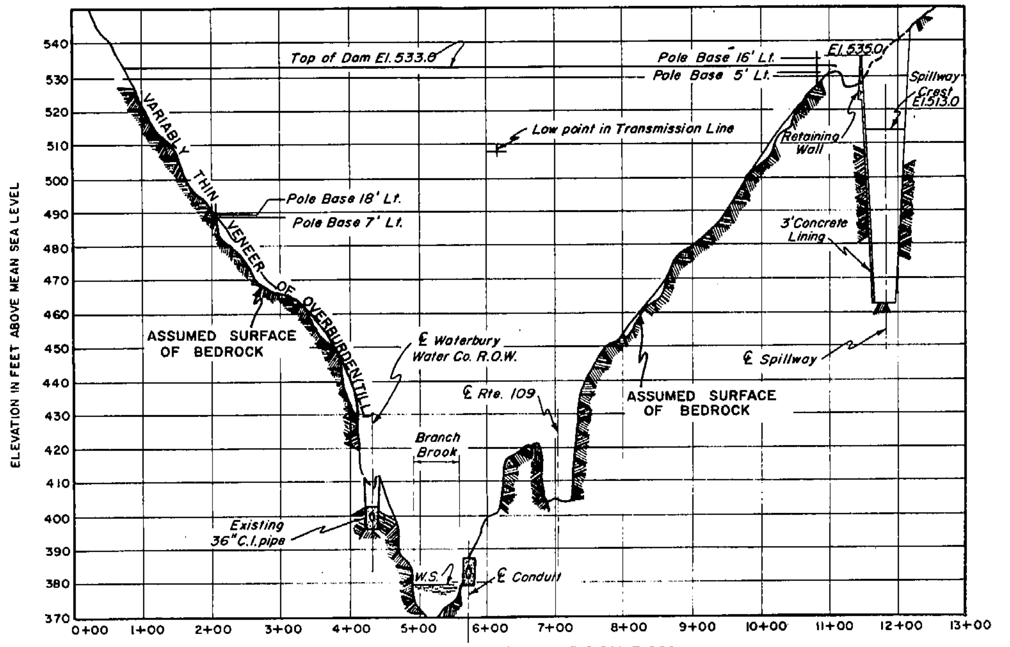
PROFILE ALONG ℄ OUTLET WORKS

SCALE: 1" = 40'



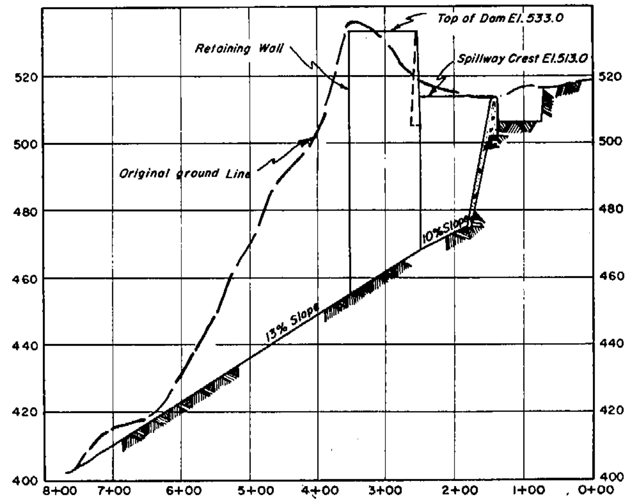
TYPICAL SECTION THRU SPILLWAY WEIR

SCALE: 1/8" = 1'



CENTERLINE PROFILE BLACK ROCK DAM

SCALE: VERT. 1" = 20' HOR. 1" = 100'



PROFILE ALONG ℄ SPILLWAY CHANNEL

SCALE: VERT. 1" = 20' HOR. 1" = 100'

NOTES:

Topography based on U.S. Army Map Service map (1:25,000-1947).
Dam profile based on field survey.
Elevations refer to Mean Sea Level Datum.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY R.P.M. | TR. BY S.J.C. | CK. BY J.W.D.

HOUSATONIC RIVER FLOOD CONTROL

BLACK ROCK DAM

GENERAL PLAN

NAUGATUCK RIVER — CONNECTICUT

PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & REPTS. BRANCH
APPROVED
CHIEF, ENGINEERING DIV.
APPROVED
LT. COL., C.E. EXECUTIVE OFFICER

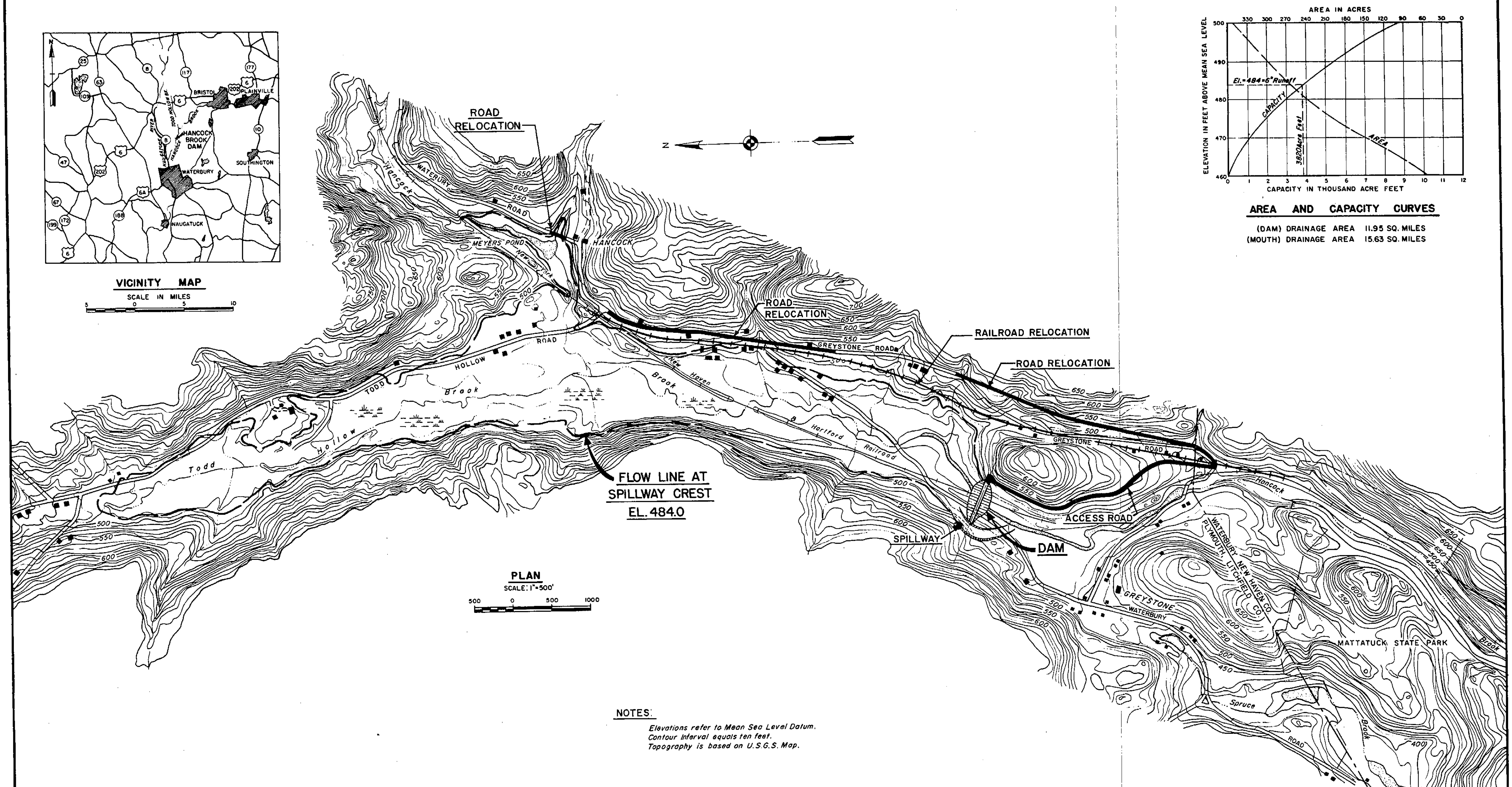
DATE JUNE 1958

TO ACCOMPANY REPORT DATED: 30 JUNE 1958

SCALE AS NOTED

DRAWING NUMBER HC-1-1315

SHEET 1 OF 1



NOTES:

Elevations refer to Mean Sea Level Datum.
Contour interval equals ten feet.
Topography is based on U.S.G.S. Map.

LEGEND

- SURFACED TOWN ROADS
- EXISTING GRAVEL ROADS
- RESERVOIR AT SPILLWAY CREST EL. 484.0
- RELOCATED HIGHWAY
- COUNTY LINE
- RELOCATED RAILROAD
- EXISTING RAILROAD

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY	TR. BY	CK. BY
W. N.	M.W.B.	J.W.D.

HOUSATONIC RIVER FLOOD CONTROL

HANCOCK BROOK DAM

RESERVOIR MAP

NAUGATUCK RIVER — CONNECTICUT

PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & REP'TS BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
LT. COL. C.E. EXECUTIVE OFFICER

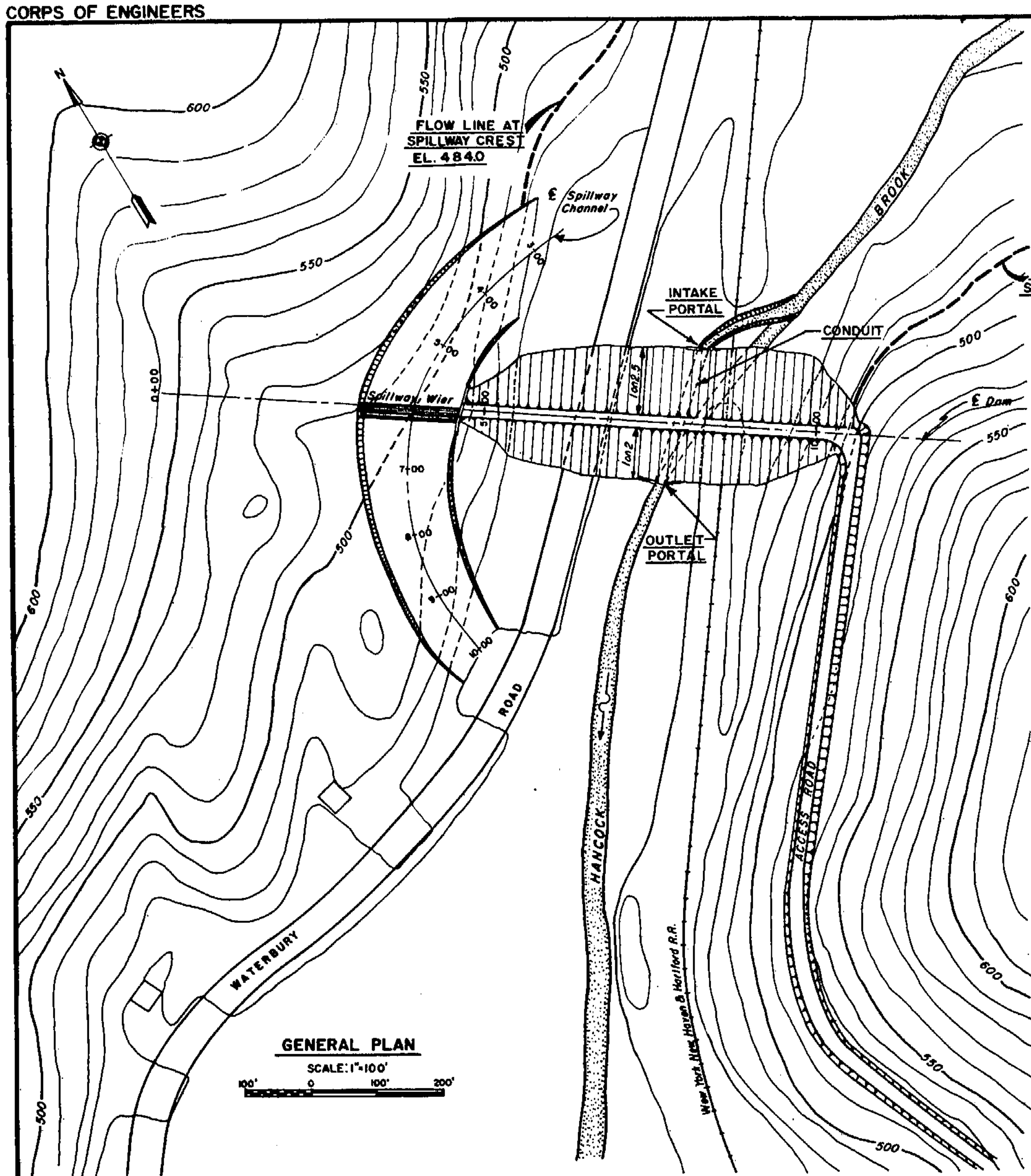
DATE JUNE 1958

SCALE AS SHOWN

TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

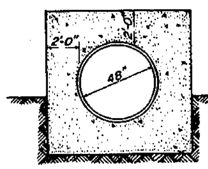
DRAWING NUMBER
HC-1-1316

SHEET 1 of 1



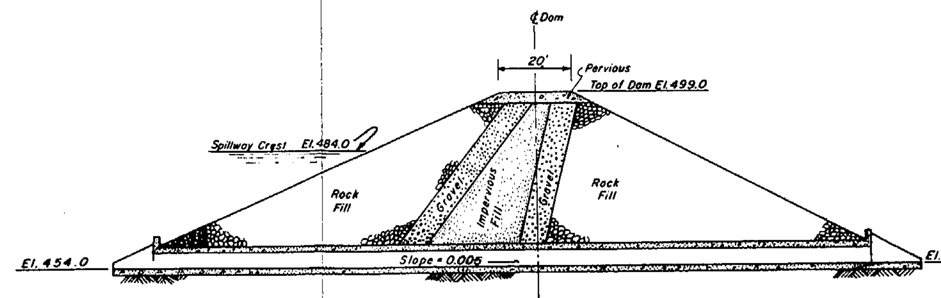
GENERAL PLAN

SCALE: 1"=100'



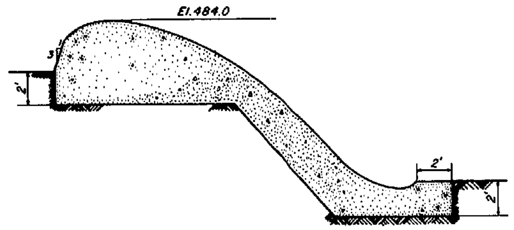
TYPICAL CONDUIT SECTION

NOT TO SCALE



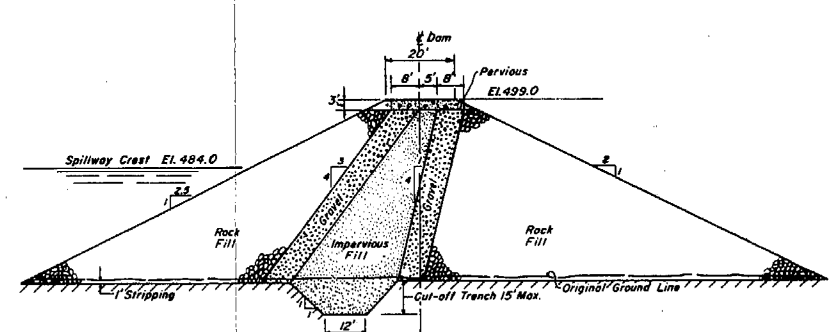
PROFILE ALONG ℄ OUTLET WORKS

SCALE: 1"=20'



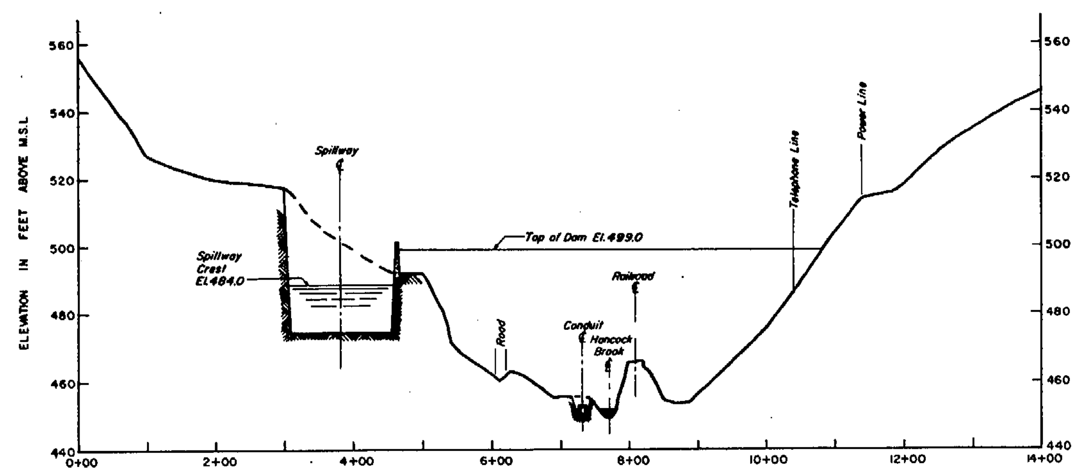
SECTION THRU SPILLWAY WIER

SCALE: 1/4" = 1'



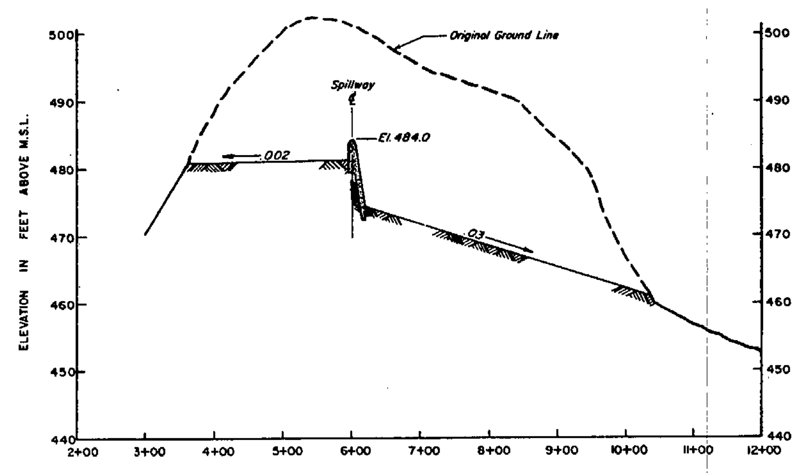
TYPICAL DAM SECTION

SCALE: 1"=20'



PROFILE ALONG ℄ DAM

SCALE: HOR. 1"=100' VERT. 1"=20'



PROFILE ALONG ℄ SPILLWAY CHANNEL

SCALE: HOR. 1"=100' VERT. 1"=10'

NOTES:

Topography based on U.S. Army Map Service map (1:25,000-1947.)
Dam profile based on field survey.
Elevations refer to Mean Sea Level Datum.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY W.T.N. | TR. BY M.W.B. | CK. BY J.W.D.

HOUSATONIC RIVER FLOOD CONTROL

HANCOCK BROOK DAM

GENERAL PLAN

NAUGATUCK RIVER CONNECTICUT

PROJECT ENGINEER — SUBMITTED BY — CHIEF, PLAN. & ENG. BRANCH — APPROVED: CHIEF ENGINEERING DIV. — APPROVED: LT. COL., C.E. EXECUTIVE OFFICER

DATE JUNE 1958

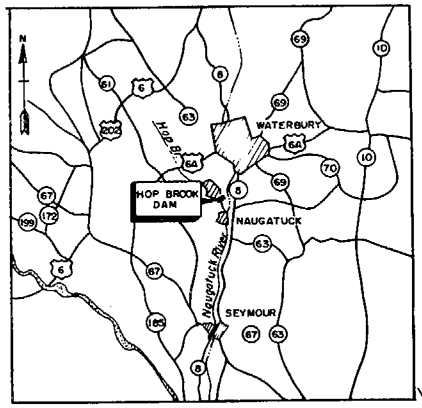
SCALE AS SHOWN

TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

DRAWING NUMBER
HC-1-1317

SHEET 1 OF 1

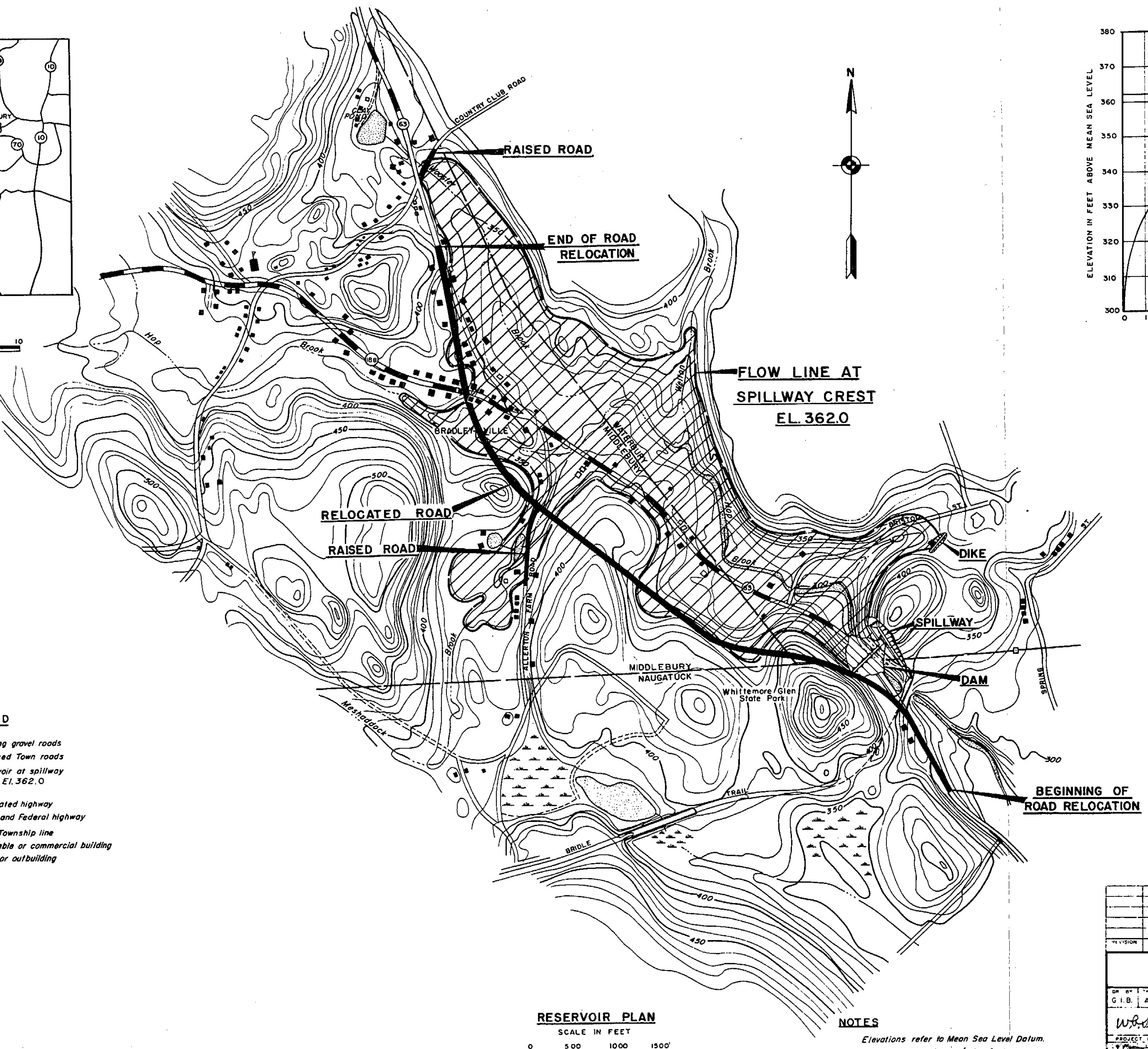
PLATE NO. 8



VICINITY MAP

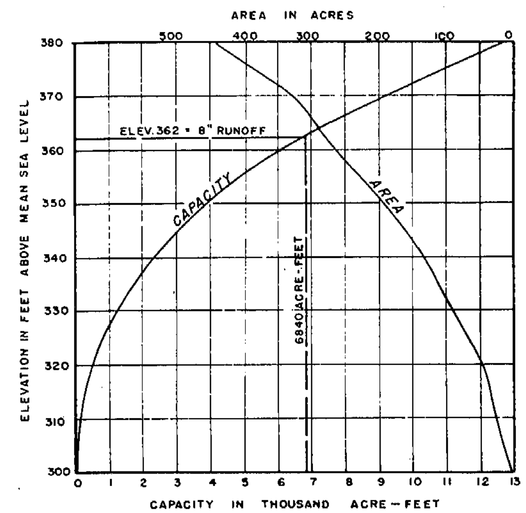
SCALE IN MILES

5 0 5 10



LEGEND

- Existing gravel roads
- Surfaced Town roads
- Reservoir at spillway crest, El. 362.0
- Relocated highway
- State and Federal highway
- Civil Township line
- ■ Habitable or commercial building
- □ Barn or outbuilding



AREA AND CAPACITY CURVES

(DAM) DRAINAGE AREA 16.04 SQ. MILES

(MOUTH) DRAINAGE AREA 16.72 SQ. MILES

RESERVOIR PLAN

SCALE IN FEET

0 500 1000 1500'

NOTES

Elevations refer to Mean Sea Level Datum.

Contour Interval equals ten feet.

Topography is based on U.S.G.S. Map.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY	TR. BY	CK. BY
G.I.B.	A.J.H.	J.W.D.

HOUSATONIC RIVER FLOOD CONTROL

HOP BROOK DAM

RESERVOIR MAP

NAUGATUCK RIVER CONNECTICUT

PROJECT ENGINEER

CHIEF, PLANNING & REPORTS BRANCH

APPROVED

CHIEF ENGINEERING DIV.

LT. COL., C.E. EXECUTIVE OFFICER

DATE JUNE 1958

SCALE AS SHOWN

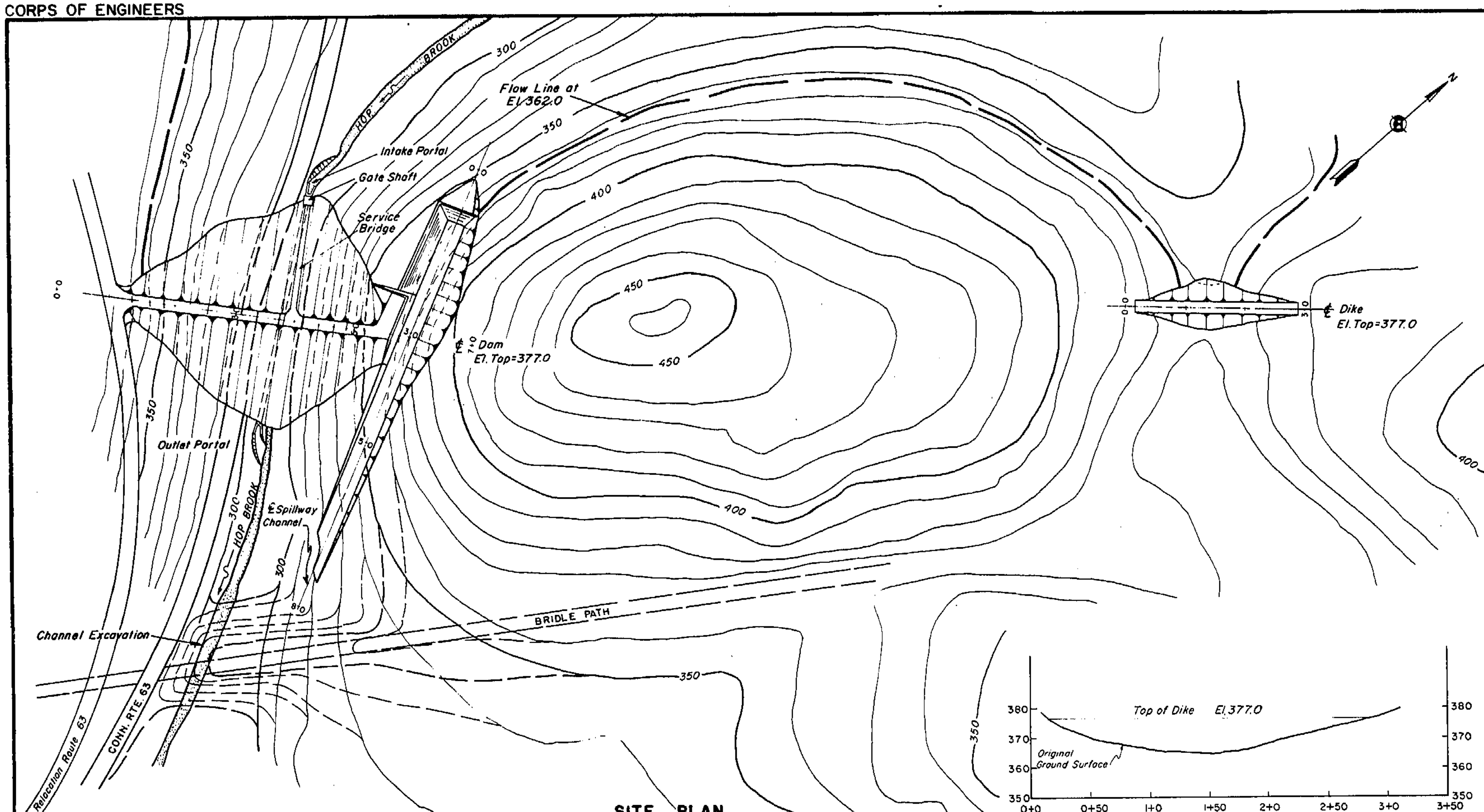
TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

DRAWING NUMBER HC-1-1318

SHEET 1 OF 1

PLATE NO. 9

(R 12/31/58)

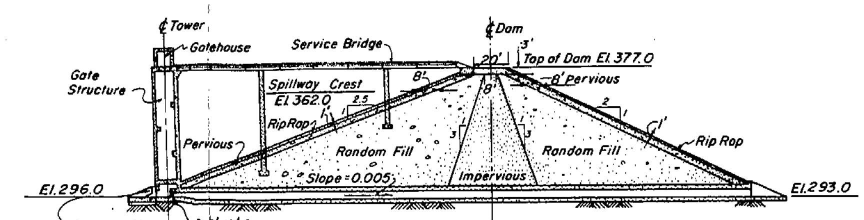


SITE PLAN

SCALE: 1" = 100'

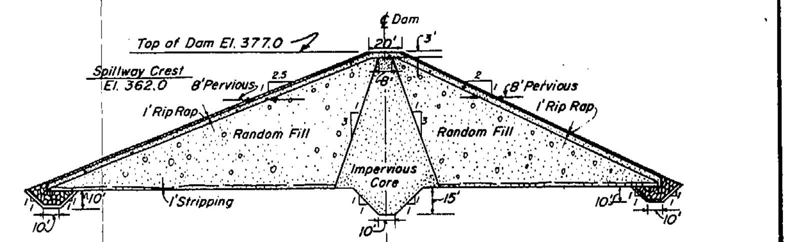
PROFILE ALONG ℄ DIKE

SCALE: Hor. 1" = 50' Vert. 1" = 20'



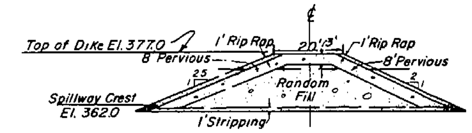
PROFILE ALONG ℄ OUTLET WORKS

SCALE: 1" = 40'



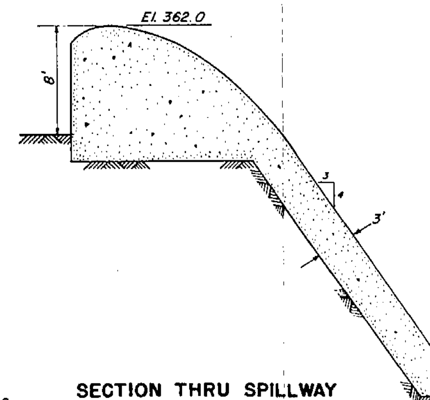
TYPICAL DAM SECTION

SCALE: 1" = 40'



TYPICAL DIKE SECTION

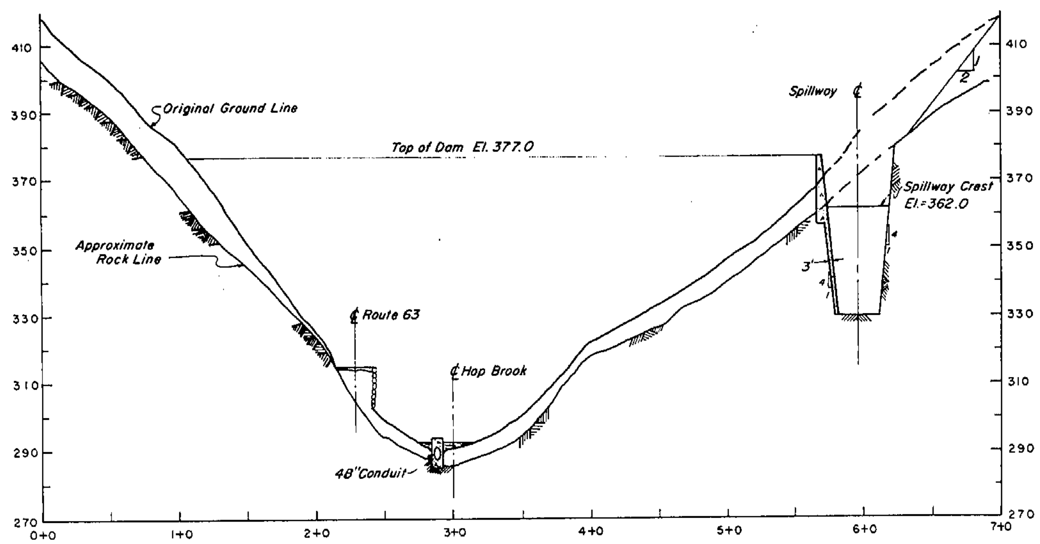
SCALE: 1" = 20'



SECTION THRU SPILLWAY WEIR

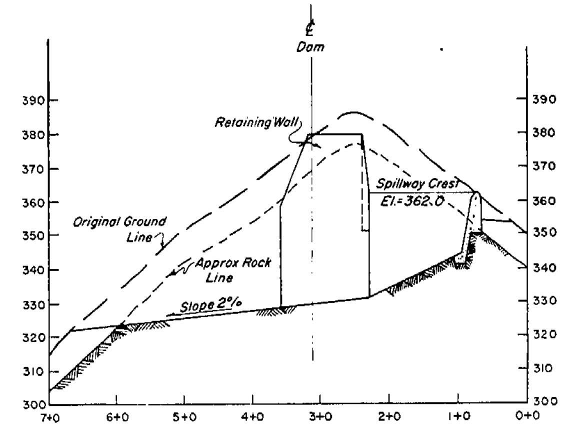
SCALE: 1" = 5'

NOTES:
Topography based on U.S. Army Map Service map (1:25,000-1947)
Dam and Dike profiles based on field survey.
Elevations refer to Mean Sea Level Datum.



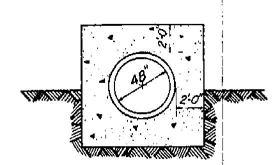
PROFILE ALONG ℄ DAM

SCALE Hor. 1" = 50' Vert. 1" = 20'



PROFILE ALONG ℄ SPILLWAY CHANNEL

SCALE Hor. 1" = 100' Vert. 1" = 20'



TYPICAL CONDUIT SECTION

SCALE: 1" = 5'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY G.I.B. | TR. BY M.W.B. | CK. BY J.W.D.

HOUSATONIC RIVER FLOOD CONTROL
HOP BROOK DAM
GENERAL PLAN
NAUGATUCK RIVER CONNECTICUT

PROJECT ENGINEER
SUBMITTED BY CHIEF, PLANN. & REPORTS BRANCH
APPROVED CHIEF, ENGINEERING DIV.
APPROVED LT. COL., C.E. EXECUTIVE OFFICER

DATE JUNE 1958
SCALE AS SHOWN
DRAWING NUMBER HC-1-1319
SHEET 1 OF 1

TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

APPENDICES

APPENDICES

TABLE OF CONTENTS

APPENDIX A

DIGEST OF PUBLIC HEARING

APPENDIX A

DIGEST OF PUBLIC HEARING AND CORRESPONDENCE

1. This appendix presents a digest of the public hearing held by the New England Division at Waterbury, Conn., on 11 December 1956. The hearing was held to determine the need for additional projects for flood control and allied purposes on the Naugatuck River, Housatonic River Basin, Connecticut.

2. There is also included in this appendix a digest of correspondence from local interests relative to the hearing.

DIGEST OF PUBLIC HEARING - 11 DECEMBER 1956

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. C. L. Eyanson, Chairman	Naugatuck Valley River Control Commission, Waterbury, Conn.	Raise the existing Woodtick Reservoir Dam on Mad River to provide flood storage capacity and construction of 5 additional flood control reservoirs on Hancock Brook, Hop Brook, Meadow Pond Brook, Bladens River, and Little River; dredging, riprapping, channelization, and retaining wall construction and diking, as necessary.	Commission approves authorized Thomaston Reservoir and the Hall Meadow Brook and E. Branch Reservoirs previously recommended for Torrington; asked that 6 prior reports of Commission be added to record of hearing; asked that consideration be given to use of dry reservoirs for farming and other purposes under easement procedures and for municipal water sources.
Mr. Garrett Burkett, Jr., State Representative	Ansonia, Conn.	- -	Desires that it be left to C of E to determine measures necessary for flood control of Naugatuck Basin.
Mr. Horace Brown, Planning Engineer	Connecticut Development Commission, Hartford, Conn.	- -	Desires that the location of flood control reservoirs and the degree of local protective devices and flood plain control be determined to some degree by water supply requirements of region, and that flood control reservoirs be used for water supply purposes if needed.
Mr. Ennis, State Representative	Thomaston, Conn.	- -	Asked for anything that could be done to hasten the purchase of property of residents and businesses being displaced by Thomaston Dam so that they could afford to relocate now.
Mayor William T. Carroll	City of Torrington, Conn.	Two dry dams above the city and a permanent flood plan for the city.	Permanent flood protection for Torrington will prove beneficial to all downstream communities.

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Chester W. Moore, Chairman	Flood and Erosion Control Board, Torrington, Conn.	Two dry dams above the city and making permanent the temporary flood control improvements in the city.	The dams above Torrington will greatly benefit the entire valley; the temporary work was made under a plan which was prepared by the C of E and carried off at city expense; therefore local interests should not be assessed for any portion of the cost of permanent work.
Mr. Edward Pikosky, Chairman, Litchfield and Erosion Control Board	Morris and Litchfield Flood & Erosion Control Boards Acting Jointly, Conn.	Channel clearance of Bantam River from Bantam Lake to Grappeville Bridge, construction of additional culvert through Grapoeville Bridge, reinforcement of railroad embankment to withstand floods, lowering or widening of power company dam as necessary to protect the Aerotherm Corp. from flooding; opening and proper protection of channel in vicinity of No Man's Swamp to either the Bantam River or Jones Pond.	These improvements needed to eliminate flooding of properties on Bantam River and Lake, to protect wildlife since the lake is a sanctuary area and a game preserve is adjacent to the lake, and to maintain the lake level for recreational purposes. (Ed. note: this area not in Naugatuck River Basin)
Mr. Charles Eggleston, 1st Selectman	Town of Thomaston, Conn.	- -	Opposed to proposed Branch Brook Dam in Thomaston because it would hamper the town's future expansion since much of the town land has already been lost because of the authorized Thomaston Dam.
Mr. George Woodbridge, Chairman	Thomaston Planning Commission, Conn.	- -	Supported statement of Mr. Eggleston. Suggested that if towns below Thomaston are really convinced that there should be 3 dams in 1 small town, they should work out a system to reimburse Thomaston for lost taxes.

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Richard D. Benson, Minority Leader	Board of Aldermen City of Waterbury, Conn.	- -	Concur in requests of Naugatuck Valley River Control Commission.
Mr. Henry Whitlock, City Engineer	Waterbury, Conn.	- -	Concur in requests of Naugatuck Valley River Control Commission.
Mayor Charles F. Clark	City of Naugatuck, Conn.	- -	Stated that when Naugatuck completed rebuilding its storm sewage drainage and when washed-out dikes are replaced, Naugatuck will be sufficiently protected. Opposed to Hop Brook and Meadow Pond Brook Dams, believing that once local improvements and Thomaston Dam are completed, both dams would probably lie idle and never be used.
Mr. Forrest G. Purinton, First Selectman	Town of Middlebury, Conn.	- -	Opposed to proposed reservoir on Hop Brook, believing that this would be detrimental to the present and future economy of Middlebury.
Mr. Philip V. R. Thomson, Chairman	Middlebury Planning and Zoning Commission, Middlebury, Conn.	- -	Opposed to proposed reservoir on Hop Brook because it would spoil definite plans which the Commission has for future economic developments in the area.
Mr. Frank W. Gray, State Representative-Elect	Middlebury, Conn.	- -	Opposed to proposed reservoir on Hop Brook. Stated that Middlebury is convinced that acceptable alternatives exist and that satisfactory control of Hop Brook and tributaries can be achieved without imposing undue hardship, either present or future, on the town or its citizens.

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Frank W. Semplenski, 1st Selectman	Town of Beacon Falls, Conn.	Remove obstructions and debris along entire length of Naugatuck River; remove High Rock Dam 3500 feet north of Beacon Falls Bridge; remove gravel bar below High Rock Dam and place spoil against east bank of river about 500 feet north of Beacon Falls Bridge; riprap river banks through entire populated area of town; widen and clear channel below Beacon Falls Bridge to Pinesbridge area and clear and straighten channel at Pinesbridge area; reconstruct bridge at Pinesbridge Rd to allow sufficient clearway for floodwater; remove unused Rimmon Pond Dam north of Seymour Center.	Concurs in requests of Naugatuck Valley River Control Commission; pushing up of gravel bar below High Rock would reduce severity of bend in river at this point and fill up old channel; unless gravel on west bank is secured, it will slide back into river.
Mr. Ernest T. Trzaski. Chairman	Beacon Falls Planning Commission, Conn.	- -	Concurs in requests of Naugatuck Valley River Control Commission.
Mr. Harry F. Mannweiler	Town of Seymour, Conn.	- -	Stated that whatever the Army Engineers plan, Seymour will go along with
Mr. Paul Pawlak, Member	Seymour Board of Education and Naugatuck Valley River Control Comm.	- -	Personally supports the requests of Naugatuck Valley River Control Commission.
Mayor Joseph A. Doyle	City of Ansonia, Conn.	Addition of a 3rd span to the New Haven RR bridge at Ansonia, which now forms a bottleneck; study of the effect of encroachments upon river channel or flood plain since October 1955.	Indorses proposed dams at Thomaston and on tributaries of Naugatuck River between Thomaston and Seymour; said that city's 3rd largest industrial plant is leaving, because of unprotected area, and relocating elsewhere.

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mayor Anthony Dirienzo	City of Derby, Conn.	- -	Urged all possible steps be taken to eliminate any possible floods in future for Derby and Naugatuck Valley; stated that if Derby were faced with repetition of 1955 floods, it would become a "ghost" town.
Mr. Cornelius F. Caldwell, Maintenance Superintendent	Charlton Press, Inc. Derby, Conn.	- -	Stated that if there is a similar flood to 1955, Charlton Press will move out.
Mr. Joseph Trzuskoski, 1st Selectman	Town of Plymouth, Conn.	- -	Asked that serious consideration be given to relocate proposed Hancock Brook Dam so as not to affect Plymouth economically.
Mr. Raymond J. Fitzpatrick, President	Board of Aldermen City of Waterbury, Conn.	- -	Wants as much flood control as possible as quickly as possible.
Mr. Carl Toothaker, Plant Engineer	Naugatuck Footwear Plant of U. S. Rubber Co.	- -	Recommends plans of both the Naugatuck Valley River Control Commission and the Corps of Engineers.
Mr. William F. Nierintz, City Engineer	City of Torrington, Conn.	- -	Indorses recommendations of Naugatuck Valley River Control Commission and favors 2 dry dams above Torrington.
Mr. Domenic Castelano, State Senator-Elect	Waterbury, Conn.	- -	Indorses C of E plan for 8 reservoirs.
Mr. Edmund S. Smith	J. E. Smith & Co., Inc. Waterbury, Conn.	- -	Indorses C of E plan for 8 reservoirs.
Mr. Howard P. Hart, Engineer	Platt Bros., Inc., Waterbury, Conn.	- -	Indorses C of E plan for 8 reservoirs.

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Zigmund Protassewicz, Vice President and General Manager	Precision Methods and Machines Inc., Waterbury, Conn.	Extension of about 1,000 ft up river of existing temporary dike in northern part of Waterbury on west bank of Naugatuck River near their property.	Indorses C of E plan for 8 reservoirs.
Mr. Robert Hopkins	Private individual	Dredging of Housatonic River from mouth of Naugatuck River downward.	Says this will help flow from Naugatuck and upper Housatonic Rivers.
Mr. Walter Okoski	Private individual, representing self and 3 other landowners in Naugatuck, Conn.	Dredging of Naugatuck River instead of dike or flood wall, where needed.	- -
Mr. Joseph Lawlor	Private individual	- -	Opposed to Long Meadow (Meadow Pond Brook) Dam, believing it would be a waste.
Mr. George C. Stasaitis	Private individual	- -	Opposed to Long Meadow (Meadow Pond Brook).
Mr. Joseph G. Killiany, Vice President	Torrington Flood Control Association, Torrington, Conn.	- -	Presented a letter signed by 28 residents of Hall Meadow in opposition to the Hall Meadow Dam.
Mr. Armand Poll	Private individual	- -	Opposed to Hall Meadow Dam; doesn't think it would be of much benefit.
Mrs. Albert F. Anderson	Private individual	- -	Opposed to 2 dams above Torrington, believing that there was no real need for the dams. Stated that City was misrepresenting amount of its damages and of its own costs for emergency local improvements.

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Ernest A. Anderson	Private individual	- -	Opposed to 2 dams above Torrington; suggested that natural flood plains be dug out to their original state and used.
Mr. Charles Foster	Private individual	- -	Opposed to 2 proposed dams above Torrington.
Mr. William J. Secor, Attorney	Himself, 46 homeowners and Naugatuck Fish & Game Club, Inc.	- -	Opposed to Hop Brook Dam. Believes that it is neither feasible, economical or necessary and will create hardship to 65 families and 5 small businesses.
Mr. Peter J. Vileisis	Private individual	- -	Opposed to Hop Brook Dam.
Mr. Nicholas Salivardi	Private individual	- -	Opposed to Meadow Pond Brook Dam.
Mr. Edmund Daikus	Private individual	- -	Opposed to Meadow Pond Brook Dam.

LETTERS AND STATEMENTS RECEIVED AT THE HEARING

Writer	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Newman E. Argraves, Commissioner	State Highway Dept., Hartford, Conn.	- -	On record as favoring construction of such parts of the overall project as are shown by the C of E to be well justified economically. Dept. would be glad to join in any joint engineering studies as may be necessary.
Mr. K. H. Case	Housatonic Lumber Co., Derby, Conn.	Protection of lower Housatonic River as well as Naugatuck.	Letter submitted by Mayor Dirienzo of Derby.
Mr. Herman L. Litsky, Proprietor	Derby Feed Store, Derby, Conn.	Dike from Derby-Shelton Bridge to new expressway bridge.	- -
Wilhelmine Sparrow	Private individual	- -	Opposed to construction of 2 dams above Torrington, believing they are unnecessary.
46 homeowners in Middlebury, Conn.	Private individuals	- -	46 individual letters accompanying petition submitted by Atty Secor, all opposed to Hop Brook Dam
Mr. Anthony A. Stien, Chairman	Naugatuck Fish & Game Club Inc., Middlebury, Conn.	One or more large dams north of Waterbury; widening of Naugatuck River from Torrington to Derby; dredging Naugatuck River deeper and use spoil for dikes on each side; reforestation; diverting small brooks to other directions where possible; removal of all small dams on Naugatuck River that hold back more than 5 acres of water; dredging small streams entering Naugatuck River for distance of several hundred feet.	Letter accompanying petition submitted by Atty. Secor; opposed to Hop Brook Dam.

Writer	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. C. L. Eyanson	Mr. Lewis A. Dibble, Jr. of Risdon Mfg. Co., Naugatuck, Conn.	- -	Letter dated 13 Dec 1956. Mr. Dibble wishes to be recorded in support of recommendations of Naugatuck Valley River Control Commission.
Mr. B. H. Sutphin, Plant Engineer, and Mr. E. H. Koenig, Asst. General Manager	New Haven Copper Co., Seymour, Conn.	- -	Indorse recommendations of Naugatuck Valley River Control Commission, the Technical Advisory Group and the C of E.
Mrs. Eugene Warner, President	Platts Mills Community Club	- -	Opposed to construction of Hop Brook Dam.
Mr. Harold P. Hanlon, Attorney	Peter J. Regan, property owner	- -	Opposed to construction of Hop Brook Dam.
Mr. P. J. Fitzgerald, President	The Fitzgerald Mfg. Co., Torrington, Conn.	Erection of dry dam on East Branch of Naugatuck River north of their factory.	Improvement would help immensely in controlling flood conditions, could further control the flow of water so as to keep available water needed for manufacturing purposes. Another disaster of the size of August 1955 could easily mean failure to reopen our plant.
Mr. Vito Cagno	Private individual	- -	Opposed to Hop Brook Dam and Reservoir.
Mr. William P. Arnold, President	Homer D. Bronson Co., Beacon Falls, Conn.	Dredging of river bed and removal of material now constricting and blocking off the westerly side of the channel.	Deposit of gravel and boulders in bed and on west side of Naugatuck from Beacon Falls bridge southward to bend in river approximately 1,600 feet below bridge now obstructing flow, and causing backup into Hockanum Brook.
Mr. Harold P. Hanlon, Attorney	Walter Roberts, Executor of Roberts Estate.	- -	Opposed to construction of Hop Brook Dam

Writer	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. R. J. Philips, Maintenance Engineer	NY, NH & H RR, New Haven, Conn.	Restoration of channel of Naugatuck River to its normal course prior to 1955 floods 1 mile north of center of Seymour where channel has shifted against the right of way of the RR.	Has caused abnormal erosion and proven to be a costly matter to replace material washed away from the action of the current during normal flow in the river.
Mr. Edmund S. Smith, Exec. Vice President	J. E. Smith & Co., Waterbury, Conn.	Use of railroad embankment in Waterbury along east side of Naugatuck R. from RR station south to Bank St. bridge as dike; and flood gate at Jackson St. underpass. Also improvement in clearances and channel width at Bank Street and railroad bridges.	Would partially protect many industries located in this area. Constrictions in river at the 2 bridges caused most of the loss of life and property in Waterbury in August 1955.
Mr. F. S. Harris, Vice President	The Kerite Company, Seymour, Conn.	- -	Favor proposed Bladens River Dam which would greatly reduce flood damages to both Kerite Mills and alleviate flood conditions in Seymour and towns below Seymour. Indorse recommendations of Naugatuck Valley River Control Commission and the C of E.
Mr. Charles J. Berberat	Berco Mfg. Co., Waterbury, Conn.	Proper arrangements to be made to keep the bridges of Waterbury open so as not to dam the water; construction of a bank along Huntingdon and Cumberland to the same height as bank built by the City Park Dept to protect the ballfield.	These are our suggestions - largely in our own interest - but we believe also of interest to all concerned in flood control.

Writer	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
- -	Seymour Mfg. Co., Seymour, Conn.	Dredging of river basin in area above former Rimmon Dam to provide desilting basin; removal of remains of old Rimmon Dam; alteration of contours of piers of the RR bridge just above their plant. Increase the span of this RR bridge to provide increased channel cross section on east bank; widen waterway area under east end of Bank St. Highway bridge; widen river channel below Broad St. opposite Union Cemetery. Riprap and make permanent existing temporary dikes on both banks of river.	If these protective measures are not effected, with a repetition of August 1955 flood, company will go out of business. The present RR piers are so designed as to divert the river flow directly at our buildings.

APPENDIX B

HYDROLOGY AND HYDRAULICS

APPENDIX B

HYDROLOGY AND HYDRAULICS

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HYDROLOGY AND HYDRAULICS

1. INTRODUCTION

This appendix presents climatological and hydrological data for the Naugatuck River Basin, the analysis of floods of record, the development of synthetic floods, the analysis of various flood control measures, and the determination of flood reductions afforded by various flood control projects.

2. BASIN DESCRIPTION

a. General. - The Naugatuck River, principal tributary of the Housatonic River, is a rapidly flowing, non-navigable stream. The watershed, which lies wholly within the western part of Connecticut, is about 50 miles long with a maximum width of 12 miles and a total drainage area of 312 square miles. (See Basin Map, Plate No. B-1). The headwaters of the Naugatuck lie about 6 miles south of the Massachusetts line in the southwest corner of the town of Norfolk at an elevation of about 1,500 feet. The general direction of flow is southerly through the communities of Torrington, Thomaston, Waterbury, Naugatuck, Beacon Falls, Seymour, Ansonia, and Derby, where the Naugatuck joins the Housatonic in its tidal reach, about 12 miles from Long Island Sound. Between the headwaters and Torrington, the river falls approximately 900 feet in about 13 miles. The Naugatuck River below Torrington slopes at a rather uniform rate of about 14 feet per mile all the way to tidewater in Ansonia. (See Plate Nos. B-2 and B-3).

b. Tributaries. - The Naugatuck River is formed by the junction of the West Branch and East Branch at Torrington with drainage areas of 33 and 14 square miles, respectively. Below Torrington, the Naugatuck River is fed by many relatively short and steep tributaries with the larger ones being: Leadmine Brook (24 sq. mi.), Branch Brook (23 sq. mi.), Hancock Brook (16 sq. mi.), Steel Brook (17 sq. mi.), Mad River (27 sq. mi.), and Hop Brook (17 sq. mi.).

3. CLIMATOLOGY

a. General. - The Naugatuck River Basin has a variable climate characterized by frequent but usually short periods of precipitation. The basin lies in the path of the "prevailing westerlies" which often include cyclonic disturbances that cross the country from the west or southwest. It is also exposed to occasional coastal storms, some of tropical origin, that travel up the Atlantic Seaboard. In late summer and autumn months these storms occasionally attain hurricane intensity. The southern portion of the basin, due to its proximity to the Atlantic coast, escapes the severity of cold and depth of snowfall experienced in the higher elevations in the northern part of the watershed.

b. Temperature. - Average monthly temperatures in the Naugatuck River basin vary widely through the year with a mean annual temperature of approximately 47° F., ranging from about 50° F. near the coast to about 44° F. in the headwaters. The minimum temperature recorded in the basin was - 25° F.; the maximum recorded was 105° F. Freezing temperatures can be expected from the middle of November until the end of March. The mean, maximum, and minimum temperatures recorded each month at Norfolk and Waterbury, Connecticut are shown on Table B-1 below:

TABLE B-1
MONTHLY TEMPERATURE RECORD
(Degrees Fahrenheit)

	Norfolk, Conn. Elevation 1,380 ft., m.s.l. 11 Years of Record			Waterbury, Conn. Elevation 340 ft., m.s.l. 67 Years of Record		
Month	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	23.3	62	-14	28.1	73	-19
February	23.8	66	-15	28.3	70	-25
March	30.2	77	-11	37.3	87	0
April	44.0	80	6	48.3	92	11
May	54.2	85	25	59.4	96	26
June	62.9	91	35	68.1	101	33
July	68.5	92	41	73.0	105	41
August	66.2	93	41	70.8	104	35
September	57.9	93	26	64.1	103	25
October	49.0	79	20	53.5	94	17
November	37.1	73	5	42.3	84	2
December	26.1	60	- 5	31.2	70	-12
Annual	45.2	93	-15	50.4	105	-25

c. Precipitation. - The mean annual precipitation over the Naugatuck River watershed is approximately 50 inches, uniformly distributed throughout the year. The maximum and minimum annual precipitations at Waterbury for 67 years through 1954 are 66.58 inches in 1901 and 31.21 inches in 1931. The rainfall gage at Waterbury was destroyed in August 1955 and was not replaced until 1957. However, annual precipitation for 1955 has been estimated at approximately 65 inches. At Norfolk at the upper limits of the watershed, the total precipitation for 1955 was 76 inches with 23.67 inches and 17.49 inches observed during August and October, respectively. Table B-2 summarizes the precipitation records at Norfolk and Waterbury.

TABLE B-2
MONTHLY PRECIPITATION RECORD
(In Inches)

Month	Norfolk, Conn. Elevation 1,380 ft., m.s.l. 11 Years of Record			Waterbury, Conn. Elevation 340 ft., m.s.l. 67 Years of Record		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	4.47	8.32	0.93	3.87	10.06	0.84
February	3.96	5.72	2.44	3.52	10.00	0.43
March	4.75	10.37	1.82	4.08	9.46	0.17
April	4.90	7.19	2.88	3.72	11.51	0.66
May	4.90	8.14	1.72	3.95	8.08	0.13
June	4.39	8.58	1.11	3.59	11.25	0.54
July	3.93	9.33	1.67	4.34	18.10	1.36
August	5.34	23.67	0.65	4.30	9.48*	0.90
September	4.34	9.25	0.92	3.66	12.90	0.90
October	4.21	17.49	1.86	3.46	8.83*	0.20
November	5.45	10.03	1.51	3.81	8.74	0.78
December	5.00	9.40	1.20	3.90	9.82	0.82
Annual	55.66	76.00	39.68	46.30	66.58	31.21

*Probably exceeded in 1955

d. Snowfall. - The annual snowfall over the watershed varies from about 35 inches near the coast to over 80 inches in the headwater region. Monthly and annual average snowfall for 35 years at Norfolk are tabulated in Table B-3.

TABLE B-3
MEAN MONTHLY SNOWFALL AT NORFOLK, CONNECTICUT
Elevation 1,380 ft., m.s.l.
(Average Depth in Inches)

Month	Snowfall
October	0.3
November	6.2
December	11.9
January	18.5
February	20.9
March	15.6
April	5.7
May	0.3

Annual----79.4

Snow cover reaches a maximum depth in late March with the water content often four to six inches.

e. Storms. - Storms that visit the northeastern section of the United States generally approach from a westerly direction and are of moderate intensity. The storms of March 1936 and December 1948 were of this type. Occasionally, tropical storms pass directly over or within striking distance of the New England States as they proceed northward. These storms are usually attended by high winds and heavy precipitation. The Naugatuck River basin has experienced four major storms of this type in recent years. These occurred in November 1927, September 1938, and August and October 1955. Plate No. B-4 is a plate of the area-depth curves for the major storms which have occurred over Northeastern United States.

(1) March 1936. A succession of 4 continental disturbances of the cold front type accompanied by heavy rains over the entire northeastern part of the United States occurred in the period of March 9-22, 1936. Heaviest rainfall occurred in the period of March 9-13 and 16-22. The Naugatuck River basin experienced an average rainfall of about 3 inches in each of these two periods.

(2) September 1938. A cold front storm, stalled along the Atlantic coast, was followed by a rapidly moving tropical hurricane, resulting in record-breaking rainfall over large areas of Connecticut, Massachusetts, New Hampshire, and Vermont. The rainfall in the Naugatuck River Basin during the 5-day period, September 17-21, 1938, averaged about 10 inches with about one-half of the total occurring on September 21.

(3) December 1948. During the last 3 days of December 1948, a deepening and intensifying area of low pressure passed northward from the middle Atlantic coast up through western Connecticut, western Massachusetts, Vermont, central New Hampshire, and Maine. Its progress was retarded by a cold front bearing down from the north. For more than 2 days, the mixing of the warm, moist air and the cold air took place over a relatively small area in western New England, producing 8 to 12 inches of rain in the area. The storm stagnated, during the afternoon of December 30 and the morning of December 31 over southwestern Connecticut, and drawing on an immense supply of warm, moist air from south of Long Island, produced 8 to 12 inches of precipitation. Isohyetals of the total storm over the Naugatuck River Basin and mass curves of precipitation for selected locations are shown on Plate No. B-5.

(4) August 1955. A high pressure system stagnated over Northeastern United States and forced hurricane Diane to move in a northeasterly direction south of Long Island on a course parallel to the southern New England coast. When hurricane Diane changed its course as it traveled south of New England, it became recharged with moisture which it literally "dumped" over southern New England. The precipitation which accompanied this storm averaged more than 13 inches in the upper Naugatuck River watershed and 10 inches in the lower basin. This precipitation fell on an area already saturated by more than 7 inches of rain during hurricane Connie the previous week. An isohyetal map of the Diane storm and mass curves of precipitation are shown on Plate No. B-6.

(5) October 1955. The October 14-17 storm was the result of a low pressure area which moved northward from the coast of Florida. The warm, moist tropical air moving up the eastern side of the low pressure area contacted the cool winds of a high pressure area over southern New England. The duration of the storm was approximately 72 hours, extending from 6 AM on October 14 to 6 AM on October 17. Heaviest rainfall occurred during the early morning hours on the 15th and 16th, with nearly continuous moderate rain during the remainder of the period. The Naugatuck River Basin experienced a total average rainfall of about 9 inches.

4. STREAMFLOW

a. Records. The U. S. Geological Survey has published records of river stages and streamflows at 4 locations in the basin for various periods of time since 1918. The records are good to excellent, except during periods of ice when they are fair. Records have been lost during major floods, but were reproduced from records at dams, with peak discharges often determined from slope-area measurements. Flow data at the gaging stations are summarized in Table B-4.

TABLE B-4

STREAMFLOW RECORDS

Location	Drainage Area Sq. Mi.	Period of Record	Discharge c.f.s.		
			Mean(1)	Maximum(2)	Minimum
Naugatuck River near Thomaston	71.9	1930-	144	41,600	7
Leadmine Brook near Thomaston	24	1930-	48.0	10,400	0.[illegible]
Naugatuck River near Naugatuck	246	1918-1924 1929-1955	470	106,000	24
Naugatuck River near Beacon Falls	261	1956-	-	-	-

(1) Through 1955
(2) Instantaneous discharge, August 1955

b. Runoff. The average annual runoff for the basin, based on 25 years of record, varies from about 27 inches for the gage near Thomaston to about 24 inches for the gaging station at Naugatuck. This represents about 50 percent of the annual precipitation, with one-third of the annual runoff occurring during the months of March and April.

5. HISTORY OF FLOODS

a. General. Outstanding floods on the Naugatuck River may result from early spring storms combined with melting snow, such as the flood of March 1936, or from summer or fall storms, such as the record flood of August 1955. In addition, local thunderstorms can cause serious flash floods on the smaller streams.

b. Floods of record. The storm of August 1955 resulted in the greatest flood of record on the Naugatuck River, caused by heavy rainfall on ground already saturated by rainfall from hurricane Connie occurring during the previous week. The earliest flood of significance in the Naugatuck River Basin occurred in February 1691. Other significant floods of about the same magnitude were recorded in November 1853 and April 1854. The flood of October 1869 was the greatest prior to 1900 with another serious flood in January 1891. Since 1900 there have been many floods, with major ones occurring in November 1927, March 1936, September 1938, New Years 1949, and August and October 1955. Table B-5 is a summary of the peak discharges at the 3 gaging stations for the 6 major floods in the past 30 years. Highwater data, where available, are shown on Plates No. B-2 and B-3.

TABLE B-5

MAJOR FLOODS - NAUGATUCK RIVER BASIN

	Leadmine Br. nr. Thomaston	Naugatuck R. nr. Thomaston	Naugatuck R. nr. Naugatuck
Drainage Area (sq miles)	24	71.9	246
Flood	Peak Discharge (c.f.s.)	Peak Discharge (c.f.s.)	Peak Discharge (c.f.s.)
November 1927	5,000 (est)	10,000 (est)	26,000
March 1936	2,680	6,590	23,340
September 1938	3,050	9,970	25,300
December 1948	5,150	10,200	28,500
August 1955	10,400	41,600	106,000
October 1955	3,100	8,800	30,400

c. Description of recent floods.

(1) March 1936. The March 1936 floods resulted from the storms of March 9-13 and 16-22. The hydrographs at all gaging stations show 2 rises separated by a recession almost to base flow. Although the rainfall in each storm averaged about 3 inches over the Naugatuck River Basin, the first rise was more than 3 times as great as the second in the lower basin. This was due to 2 basic factors, (1) most of the rainfall in the first storm fell within 24 hours while the second was over a 48-hour period, and (2) the first flood was augmented by snowmelt from the higher elevations and minor ice jams.

(2) September 1938. The storm producing the flood started with light rain, gradually increasing in intensity over a 4-day period and ending with a heavy downpour associated with the hurricane that struck New England on the 21st of September. This rainfall pattern was especially conducive to high peak discharges due to the filling of ponds, lakes, and swamps, and satisfying of initial soil moisture deficiencies before the intense rainfall occurred. Moreover, rainfall during the previous month was heavier than normal, thereby helping to reduce the initial storage and infiltration losses.

(3) December 1948. The storm which produced this flood deposited 4 to 9 inches of rain in approximately 48 hours over the Naugatuck Valley. This flood crested at stages slightly higher than the September 1938 flood and became the maximum of record prior to 1955. Flood hydrographs for selected locations and a peak discharge profile are shown on Plate No. B-5.

(4) August 1955. The greatest flood of record in the Naugatuck River Basin occurred in August 1955. As shown in Table B-5, the peak discharges were 3 to 4 times the magnitude of any other flood. Between August 11-15, hurricane Connie brought 4 to 8 inches of rainfall to the basin, but very little runoff occurred due to the unusually dry antecedent conditions. However, when hurricane Diane deposited the record amounts of between 10 and 13 inches of precipitation on regions previously saturated by the rainfall of hurricane Connie, runoff of record proportions occurred. Most of the rain fell in a 24-hour period between 7 AM August 18 and 7 AM August 19, 1955. The failure of many dams and bridges contributed substantially to peak discharges. Flood hydrographs for selected locations and a peak discharge profile of the August 1955 flood are shown in Plate No. B-6. Further discussion of this flood is included in paragraph 6.

(5) October 1955. The flood occurring as the result of the storm of October 14-17, 1955 was confined to southwestern

Connecticut and western Massachusetts. It was the second largest flood of record in lower portions of the Naugatuck River Basin. Abnormally high tides contributed to the flood stages in the communities of Derby and Ansonia.

d. Frequency. - The frequency or percent chance of occurrence of flood discharges was determined from records of all gaging stations in the Naugatuck and adjacent river basins. The frequency analyses were made in accordance with procedures devised by Mr. L. R. Beard, Corps of Engineers. The method considers that the logarithmic value of annual peak flows are normally distributed, thereby permitting the application of standard statistical analysis. This enables the discharge frequency curve to be defined by its mean values and standard deviation therefrom. The procedure is described in Civil Works Engineers Bulletins 51-1 and 51-4. The application to New England Rivers is summarized in F. C. S. Memorandum No. 52-General-3, "Flood Frequency Studies in New England." Following the August and October floods of 1955, new frequency studies were initiated for all New England river basins. The mean and standard deviations for each gaged area were recomputed to include five years of additional flow data. Based on a regional analysis, a skew coefficient adopted for the Naugatuck River Basin was revised from 0.3 to 1.0. The natural peak discharge frequency curves for the locations at U. S. Geological Survey gaging stations are shown on Plate No. B-7.

6. ANALYSIS OF FLOODS

a. General. - An analysis of all recent floods in the Naugatuck River Basin was made in order: (1) to determine the discharge contribution of tributaries and local areas to flood flows at the principal damage centers, and (2) to properly evaluate (a) flood characteristics and potentialities of the various streams, and (b) the necessity for reservoir control and/or local protection measures. These determinations were based on detailed studies of data collected during and after the major floods of March 1936, September 1938, December 1948, and August 1955. Data for the October 1955 flood was generally inadequate for analysis because of the loss of the gage at Naugatuck and the poor condition of the channel following the August flood.

For purposes of hydrologic and hydraulic analyses, the Naugatuck River Basin was divided into basin subdivisions and routing reaches.(See Plate No. B-1). The basin subdivisions were selected to fully utilize recorded hydrographs and other observed flood data. The limit of the routing reaches were located at U. S. Geological Survey gaging stations, at the mouths of principal tributaries or at other control points, such as dams where discharges could be computed. The component hydrographs for the basin subdivisions were either obtained from gaging station records or developed synthetically from the observed hydrographs and rainfall data of comparable gaged areas. The component hydrographs were routed downstream to determine their contribution to the flood peaks at downstream damage centers, using the Progressive Average-Lag Method of flood routing described in the following paragraph.

b. Flood routing. The Progressive Average-Lag Method of flood routing was adopted for use in the Naugatuck River Basin because of its adaptability for component routing. The method is empirical and develops an arithmetic relationship between inflow and outflow for a given reach, allowance being made for the distance of travel, the storage in the reach, the amount of intervening inflow, and relative timing of the peak flows. This method is described in E. M. Civil Works, Part CXIV, Chapter 8, September 1953, (ER 1110-2-1408). The flood routing coefficients in the Naugatuck River Basin varied with the magnitude of the flood. This is due to the change of flow characteristics with increased discharges as well as the increased number of failures of bridges and temporary dams from debris. These conditions are discussed in the following paragraphs.

c. Flood characteristics.

(1) General. From studies of floods of record it was evident that the Naugatuck River Basin is subject to floods that develop very quickly. Critical floods may occur during any month of the year and may develop from rainfall alone. Intensity of rainfall and antecedent conditions, rather than total volume, usually determine the magnitude of the flood peaks in the Naugatuck River Basin. This was evident in the storm of August 1955 when the total rainfall was only about one-third greater than the flood of December 1948, but the flood peaks were almost 4 times the magnitude. In most cases the flood hydrographs were very steep with peaks of short duration.

(2) Relative timing of flood crests. The quick development of the floods is due to the topography of the basin, wherein the main channel has an average slope of about 14 feet per mile through most of its length. In addition, it is fed by many small tributaries which fall about 200 to 300 feet in the relatively short distance of 3 or 4 miles. This stream pattern combined with a lack of natural or artifical storage results in a very short time of concentration for the runoff to develop. The path of the storm as it crosses the long, narrow basin, together with the intensity of rainfall, will affect the relative time of flood crests. Plate No. B-8 is a plot of the time of flood crests as related to the

peak at the U. S. G. S. gage near Naugatuck, Connecticut. The relative difference in timing of these floods is very small despite the wide range in flood magnitudes. This characteristic reflects the rapid development of the flood on the main river, and is produced by the many tributaries literally "dumping" their contents into the main channel almost simultaneously through the entire valley. With no storage available, this water in the main channel rises very quickly until the water surface is nearly parallel with the steep gradient of the river bed. The hydraulic characteristics of the river channel change with the rapid rise in river stages, thus creating high destructive velocities throughout the entire river. In the August 1955 flood, debris dams were formed temporarily at constrictions, further raising the flood stages. Failure of these temporary dams produced surges which undoubtedly caused chain reactions downstream, further aggravating the already critical conditions.

(3) Source of floods. - The source or origin of floods above each damage center was determined in order to establish the value of upstream reservoirs. A summary of the discharge contributions from selected areas to the flood peaks at Torrington, Thomaston, Waterbury, Naugatuck, and Ansonia is tabulated in Table B-6 and shown graphically on Plates B-5 and B-6.

d. Standard project flood. - The standard project flood developed for the Naugatuck River was based on the standard project storm rainfall as described in Civil Engineer Bulletin No. 52-8, and in unit hydrographs derived from analyses of record floods.

(1) Standard project storm. - The standard project storm was oriented in the lower part of the basin to determine the need for supplementary flood protection after Thomaston Reservoir. Consideration was given to increasing the volume of the storm on the basis of the precipitation experienced in August 1955. However, as noted in paragraph 6 c., flood peaks in the Naugatuck River basin are a function of rainfall intensity and antecedent conditions. The intensities of the standard project storm are greater than those occurring in August 1955, hence will produce higher peak discharges. The adoption of high unit hydrographs, as described in the next paragraph, infers antecedent rainfall that saturates the ground and justifies the assumption of rapid runoff conditions.

(2) Unit hydrographs. - Unit hydrographs were derived for the gaged areas in Naugatuck Basin from investigations of floods of record. Analyses of the flood hydrographs

experienced in August 1955 resulted in unit hydrographs much larger than previously computed, thus demonstrating that peaks of unit hydrographs vary considerably with the magnitude of the flood. (See Plates B-8a and B-8b). Application of these higher unit hydrographs resulted in a greater standard project flood than derived in previous studies. Unit hydrographs for the ungaged tributaries were based on the unit hydrograph developed for Leadmine Brook, considering the difference in drainage area characteristics.

(3) Flood discharges.

(a) Natural. The standard project flood runoff from the component areas routed and combined at Naugatuck produced a maximum discharge of 138,000 c.f.s., which is about 30 percent greater than experienced in the record flood of August 1955. A major reason for this difference in magnitude is the orientation of the 2 storms. The heavier rainfall in August occurred in the upper part of the watershed while the standard project storm was located to make conditions most critical in the lower basin. A summary of the standard project flood derivation is shown on Plate B-9 with tributary and local contributions tabulated in Table B-6.

(b) Modified. In determining the standard project flood, as modified by Thomaston and the proposed reservoirs, it was assumed that the flood control reservoirs were empty at the beginning of the storm. The reservoirs would be filled during the standard project flood but spillway discharges would be minor and would not contribute to the downstream flood peaks. The standard project flood peak at Naugatuck, as modified by the proposed reservoirs, is 58,000 c.f.s., which is about 50 percent greater than the August 1955 flood modified by the same system of reservoirs. Local protection projects at damage centers, studied as part of the basin review, were designed on the basis of the modified standard project flood. As no local protection works have been found economically feasible, the standard project flood has been used primarily to demonstrate the effectiveness of the proposed reservoirs.

e. Typical tributary contribution flood. In order to evaluate the relative flood control effectiveness and the economics of projects, a synthetic flood was developed to represent a typical distribution of tributary flood contributions in the Naugatuck River Basin. The floods of record were used to determine the relative shape and timing of the component hydrographs with the peak discharge and volume related to frequency curves and average annual runoff, respectively. These component hydrographs were combined and routed, where necessary, to develop the main river hydrographs. Typical routing coefficients were selected from analyzing record floods. Tributary and local contributions to the TTCF peaks at various locations are tabulated in Table B-6. A detailed explanation of the derivation and application of a TTCF are given in the report of the New England - New York Inter-Agency Committee, Part 3, Volume 3, Section XIX.

7. FLOOD CONTROL PLANS

a. General. - The recommended flood control plan for the Naugatuck River includes the authorized reservoir at Thomaston and proposed reservoirs on Northfield, Branch (Black Rock), Hancock, and Hop Brooks. In addition, East Branch and Hall Meadow Brook reservoirs on the East and West Branches above Torrington have been recommended in a previous report. (Interim Report Review of Survey, Upper Naugatuck River, May 1956). Pertinent data for the reservoir system are tabulated in Table B-7 and summarized in the following paragraphs.

b. Thomaston Reservoir. - The Thomaston dam site is located on the Naugatuck River about 0.2 miles below the confluence of Leadmine Brook. The dam which is currently under construction, will be of rolled earth and rock fill construction with a concrete side channel spillway in the left abutment. The reservoir at spillway crest will have an area of 960 acres and will extend about seven miles upstream on the Naugatuck River and about three miles upstream on Leadmine Brook. The flood control capacity of the reservoir will be 42,000 acre-feet, equivalent to 8.1 inches of runoff from the drainage area of 97.2 square miles.

c. Previously recommended reservoirs. -

(1) Hall Meadow Brook. - The dam site is located in the city of Torrington on Hall Meadow Brook. 0.4 miles above its confluence with the West Branch of the Naugatuck River. The project would consist of a rolled earth-fill dam, 55 feet high and 1080 feet long with a spillway located in a saddle in the left abutment. The capacity of the reservoir at spillway crest elevation of 890.0 m.s.l. would be 7200 acre-feet, equivalent to 11.1 inches of runoff from the drainage area of 12.2 square miles.

(2) East Branch. - The East Branch dam site is located in the city of Torrington on the East Branch of the Naugatuck River, 3.0 miles above its confluence with the West Branch. The drainage area at the dam site is 9.25 square miles. The project would consist of a rolled earth-fill dam 95 feet high and 886 feet long with a side channel spillway

TABLE B-6

TRIBUTARY CONTRIBUTIONS

TO

NAUGATUCK RIVER FLOOD PEAKS

Location	Contributing Component (1)	Drainage Area (sq. mi.)	Drainage Area (%)	December 1948 (c.f.s.)	December 1948 (%)	August 1955 (c.f.s.)	August 1955 (%)	October 1955 (c.f.s.)	October 1955 (%)	Standard Project Flood (c.f.s.)	Standard Project Flood (%)	T.P.C.F. (c.f.s.)	T.P.C.F. (%)
				Contributions to Peak Discharges									
Torrington	E & W Branches	48	100.0	7,500	100.0	25,000	100.0	3,500	100.0	35,000	100.0	20,000	100.0
Thomaston	E & W Branches	48	49.5	7,200	51.1	18,400	35.8	3,000	30.0	30,500	44.8	17,000	42.5
	Leadmine Brook	24	24.7	4,100	29.1	9,800	19.1	2,200	22.0	20,500	30.2	10,500	26.2
	Area - Torrington to Thomaston	25	25.8	2,800	19.8	23,200	45.1	4,800	48.0	17,000	25.0	12,500	31.3
		97	100.0	14,100	100.0	51,400	100.0	10,000	100.0	68,000	100.0	40,000	100.0
Waterbury	E & W Branches	48	26.6	6,200	28.7	18,500	20.5	2,700	13.5	24,000	22.4	14,000	23.3
	Leadmine Brook	24	13.3	3,200	14.8	9,800	10.9	2,000	10.0	18,500	17.3	8,700	14.5
	Area - Torrington to Thomaston	25	13.9	2,600	12.0	23,200	25.8	4,300	21.5	13,500	12.6	10,300	17.2
	Area - Thomaston to Waterbury	83	46.2	9,600	44.5	38,500	42.8	11,000	55.0	51,000	47.7	27,000	45.0
		180	100.0	21,600	100.0	90,000	100.0	20,000	100.0	107,000	100.0	60,000	100.0
Naugatuck	E & W Branches	48	19.5	6,100	21.4	17,200	16.2	2,500	8.2	20,000	14.5	11,900	17.8
	Leadmine Brook	24	9.8	3,100	10.9	9,000	8.5	1,900	6.2	13,500	9.8	7,400	11.0
	Area - Torrington to Thomaston	25	10.2	2,600	9.1	21,600	20.4	4,000	13.2	11,000	8.0	8,700	13.0
	Area -Thomaston to Waterbury	83	33.7	8,200	28.8	39,500	37.3	10,000	32.9	60,000	43.4	25,500	38.0
	Area - Waterbury to Naugatuck	66	26.8	8,500	29.8	18,700	17.6	12,000	39.5	33,500	24.3	13,500	20.2
		246	100.0	28,500	100.0	106,000	100.0	30,400	100.0	138,000	100.0	67,000	100.0
Ansonia	E & W Branches	48	15.5	6,000	18.3	13,300	11.9	2,500	6.2	17,000	11.5	11,300	15.2
	Leadmine Brook	24	7.7	3,100	9.5	7,000	6.2	1,900	4.8	11,000	7.4	7,000	9.5
	Area - Torrington to Thomaston	25	8.0	2,600	8.0	16,700	14.9	4,000	10.0	10,000	6.8	8,200	11.1
	Area - Thomaston to Waterbury	83	26.7	7,300	22.3	38,900	34.8	9,300	23.2	52,000	35.1	24,500	33.1
	Area - Waterbury to Naugatuck	66	21.2	7,700	23.6	17,500	15.6	11,100	27.8	37,000	25.0	13,000	17.6
	Area - Naugatuck to Ansonia	65	20.9	6,000	18.3	18,600	16.6	11,200	28.0	21,000	14.2	10,000	13.5
		311	100.0	32,700	100.0	112,000	100.0	40,000	100.0	148,000	100.0	74,000	100.0

(1) See Plate No. B-1

TABLE B-7

PERTINENT DATA

COMPREHENSIVE SYSTEM - DAMS AND RESERVOIRS

NAUGATUCK RIVER BASIN

Project	Authorized	Previously Recommended		Proposed			
	Thomaston	Hall Meadow Brook	East Branch	Northfield Brook	Black Rock	Hancock Brook	Hop Brook
Stream	Naugatuck R.	West Branch	East Branch	Northfield Brook	Branch Brook	Hancock Brook	Hop Brook
Drainage Area, sq. mi.	97.0	12.2	9.25	5.7	20.8	12.0	16.0
Reservoir Area, acres	1465	350	180	60	180	300	280
Reservoir Storage							
Acre Feet	42,000	7200	5.150	2430	8860	3820	6840
Inches of Runoff	8.1	11.1	10.5	8.0	8.0	6.0	8.0
Dam:							
Type	Rolled earth and rock	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rock fill	Rolled earth
Crest length, feet	2000	1080	740	800	1100	615	470
Maximum height, feet	142	55	95	118	153	50	82
Spillway:							
Type	L-Shaped, side-channel	Ogee-chute	Side-channel	Ogee-chute	Side-channel	Ogee-chute	Side-channel
Crest length, feet	450	200	175	70	170	145	230
Surcharge, feet	18	10	10	10	10	15	10
Design discharge, c.f.s.	132,200	25,000	22,000	8400	37,500	17,500	27,500
Outlet Works:							
Type	10' horseshoe conduit	45" diam. conduit	38" diam. conduit	36" diam. conduit	54" diam. conduit	48" diam. conduit	48" diam. conduit
No. and Size of gates	2 - 5' 8" x 10'	Ungated	Ungated	Ungated	2 - 3' x 4'	Ungated	2 - 3' x 3'
Discharge at Spillway crest, c.f.s.	5300	290	250	175	660	375	450
Channel capacity below dam, c.f.s.	3500	300	250	160	600	350	400
Elevations: (feet, mean sea level)							
Invert Elevation	380.0	850.0	800.0	472.0	384.0	454.0	296.0
Spillway Crest	494.0	890.0	871.0	573.0	513.0	434.0	362.0
Top of Dam	517.0	905.0	886.0	588.0	533.0	499.0	377.0

in the right abutment of the dam. The capacity of the reservoir at spillway crest elevation of 8760 m.s.l. would be 5,150 acre-feet equivalent to 10.5 inches of runoff from the tributary drainage area.

d. Proposed reservoirs. -

(1) Northfield Brook. - The dam site is located on Northfield Brook one mile upstream from its confluence with the Naugatuck River in the Town of Thomaston, Conn. The dam would be of rolled earth-fill construction approximately 800 feet long and have a maximum height of 118 feet above the stream bed. A chute spillway with an ogee weir will be founded on rock in the abutment of the dam. The reservoir at spillway crest would have a surface area of approximately 60 acres and would extend about 1.2 mile upstream. The storage capacity of 2430 acre-feet would be equivalent to 8.0 inches of runoff from the tributary drainage area of 5.7 square miles.

(2) Black Rock. - This dam site is located on Branch Brook 1.8 miles upstream from its confluence with the Naugatuck River in the Town of Thomaston, Conn. The dam would be of rolled earth-fill construction, approximately 1100 feet long and have a maximum height of 183 feet above the stream bed, with a side channel spillway in the left abutment. The reservoir at spillway crest would extend about 1.3 miles up Branch Brook and have a surface area of approximately 180 acres. The flood control storage capacity of 8856 acre-feet would be equivalent to 8.0 inches of runoff from the tributary drainage area of 20.8 square miles.

(3) Hancock Brook. - The dam site is located on Hancock Brook 3.4 miles upstream from its confluence with the Naugatuck River in the Town of Waterbury, Conn. The dam would be of rolled earth-fill approximately 615 feet long and have a maxi mum height of 50 feet above the stream bed. A chute spillway with an ogee weir would be founded in rock in the right abutment of the dam. The reservoir at spillway crest will extend upstream about 1.4 miles on Hancock Brook and 1.2 miles on Todd Hollow Brook and have a surface area of approximately 300 acres. The flood control capacity at spillway crest of 3820 acre-feet equivalent to 6.0 inches of runoff from the tributary drainage area of 12.0 square miles.

(4) Hop Brook. - The Hop Brook dam site is located on Hop Brook in the town of Middlebury, Connecticut, approximately 1.2 miles upstream of its confluence with the Naugatuck River. The dam would be about 470 feet long with a maximum height of 82 feet above the stream bed. It would be of earth filled construction with a side channel spillway with an L-shaped

ogee weir in the left abutment. The reservoir at spillway crest would have an area of approximately 280 acres and would extend upstream about 1.6 miles. The reservoir would have a flood control capacity of 6800 acre-feet of storage, equivalent to 8.0 inches of runoff from the tributary drainage area of 16.0 square miles.

e. Spillway and outlet capacities. -

(1) Spillway capacities. Spillway capacities for dams in the Naugatuck River Basin have been derived in accordance with established procedure involving detailed unit hydrographs and synthetic storms of probable maximum precipitation centered over the watersheds. The data for the probable maximum precipitation have been taken from Hydrometeorological Report No. 33. Consideration was given to the need for revising this data in view of the phenomenal storm of August 17-20, 1955. It was determined, however, that for relatively small watersheds the probable maximum rainfall provides a much more severe criterion than the 1955 storm and that no revision was required.

Unit hydrographs were derived from all applicable flood records in the basin, and for adjacent rivers where watershed characteristics were comparable. Plates B-8a and B-8b are summary sheets of unit hydrograph analysis for the U.S. Geological Survey gaging stations near Thomaston Dam. The unit hydrographs from the August 1955 flood were adopted with the unit hydrograph for Leadmine Brook, adjusted for drainage area differences used to develop the spillway design flood for the ungaged tributaries. Due to the high peak values and short period of concentration, it was considered that these unit hydrographs would give conservative estimates for developing spillway design flood inflows. The hydrographs of the spillway design floods were derived by correlating the rainfall excess (assuming losses to be 0.05 inches per hour) with the adopted unit hydrographs.

The spillway design floods were routed through surcharge storage, assuming outlets operative, to determine various lengths of spillway versus surcharge elevations. The selected length of spillway and corresponding surcharge was based on the most economical combination. Freeboard requirements were computed for each dam based on fetch criteria and an assumed wind velocity concurrent with maximum surcharge. In general, a minimum freeboard of five feet has been used to determine the top elevation of the non-overflow sections of the dam. Pertinent data for the spillways are included in Table B-7.

(2) Outlet capacities. - Outlet sizes were selected to satisfy the following criteria: (a) obtain outlet discharges equivalent to the downstream safe channel capacity with a pool elevation corresponding to 20 percent of the reservoir storage, (b)

permit emptying the reservoir in a reasonable period of time, and (c) provide adequate diversion capacity during construction. The sizes of ungated outlets were tentatively selected to maintain channel capacities with a reservoir stage slightly below spillway crest.

The type of outlet selected for each dam was based on the type of dam, site limitations, and economics. The number and size of gates were selected to provide flexibility during all operating conditions and provide sufficient capacity to satisfy the preceding outlet criteria with 1 gate inoperative. Discharge rating curves were determined by conventional methods of evaluating head losses for friction, entrance, gate slots, and transitions in terms of the velocity head at the portal. Pertinent data for the outlets are also shown in Table B-7.

f. Effect of flood control plans. The effectiveness of each reservoir, acting alone or in various combinations with Thomaston was determined as measured by the TTCF. The final recommended system was tested by the flood of record and the Standard Project Flood. Table B-8 is a summary of the natural and modified river stages and discharges for various floods as modified by Thomaston alone and the comprehensive system at principal damage centers.

g. Reservoir regulation. The Hall Meadow Brook and East Branch Reservoirs in the upper Naugatuck River Basin will be operated primarily for the City of Torrington. The other reservoirs will be operated as a system to maintain flows within safe channel capacities insofar as possible. Key index points for regulating discharges will be Waterbury, Naugatuck, and Ansonia. The reservoirs at Northfield Brook and Hancock Brook would be ungated and will act as simple retarding basins. Control gates in the other structures will be partially or completely closed whenever the flows at the index points are expected to exceed the channel capacities. Actual regulation experience will be required to determine the safe channel capacities which are tentatively estimated as follows:

Location	Estimated channel capacity in c.f.s.
Waterbury	10,000
Naugatuck	15,000
Ansonia	18,000

Plates B-5, B-6, and B-9 show the effect of the proposed regulation on the floods of December 1948 and August 1955 and standard project flood. The regulation of the reservoirs is demonstrated in Plate B-10 which shows the operation for the standard project flood. Some spillway discharge would have occurred but this discharge would generally occur during the flood recession and hence would not synchronize with the peak flows from the uncontrolled areas. The reservoirs will be emptied as quickly as possible, utilizing the full capacity of the downstream river channel. Details for the regulation of all reservoirs in the Naugatuck River Basin will be incorporated in a Master Regulation Manual for the basin.

TABLE B-8

EFFECT OF FLOOD CONTROL PLANS AT DAMAGE CENTERS

NAUGATUCK RIVER BASIN

Damage Center	Low Water Stage	December 1948 Natural Stage ft.	December 1948 Natural Flow c.f.s.	December 1948 Modified Stage ft.	December 1948 Modified Flow c.f.s.	December 1948 Reduction Stage ft.	December 1948 Reduction Flow c.f.s.	August 1955 Natural Stage ft.	August 1955 Natural Flow c.f.s.	August 1955 Modified Stage ft.	August 1955 Modified Flow c.f.s.	August 1955 Reduction Stage ft.	August 1955 Reduction Flow c.f.s.
AUTHORIZED PLAN (Thomaston)													
Waterbury, Conn. (West Main St. Bridge)	3.0	15.0	21,600	10.5	9,600	4.5	12,000	28.5	90,000	21.0	42,000	7.5	48,000
Naugatuck Conn. (U.S.G.C. Gage)	2.0	12.5	28,500	9.5	16,700	3.0	11,800	26.0	106,000	19.0	59,000	7.0	47,000
Ansonia, Conn. (Maple St. Bridge)	4.0	17.0	32,700	13.0	21,000	4.0	11,700	26.0	112,000	22.0	75,000	4.0	37,000
COMPREHENSIVE PLAN													
Torrington, Conn. (Below East Branch)	3.0	14.0	7,500	11.0	4,000	3.0	3,500	22.0	25,000	18.0	14,200	4.0	10,800
Waterbury, Conn. (West Main St. Bridge)	3.0	15.0	21,600	8.0	5,000	7.0	16,600	28.5	90,000	14.5	23,500	14.0	66,500
Naugatuck, Conn. (U. S. G. C. Gage)	2.0	12.5	28,500	7.0	10,500	5.5	18,000	26.0	106,000	15.0	38,000	11.0	68,000
Ansonia, Conn. (Maple St. Bridge)	4.0	17.0	32,700	11.5	15,600	5.5	17,100	26.0	112,000	19.0	54,000	7.0	58,000

Note: Comprehensive Plan includes the following additional reservoirs:

Hall Meadow Brook
East Branch
Northfield Brook
Black Rock
Hancock Brook
Hop Brook

TABLE B-8 (cont.)

EFFECT OF FLOOD CONTROL PLANS AT DAMAGE CENTERS

NAUGATUCK RIVER BASIN

Damage Center	Low Water Stage	Standard Project Flood						T.T.C.F. (1)		
		Natural		Modified		Reduction		Natural	Modified	Reduction
		Stage ft.	Flow c.f.s.	Stage ft.	Flow c.f.s.	Stage ft.	Flow c.f.s.	Flow c.f.s.	Flow c.f.s.	Flow c.f.s.
AUTHORIZED PLAN (Thomaston)										
Waterbury, Conn. (West Main St. Bridge	3.0	31.5	107,000	22.5	53,000	9.0	54,000	60,000	27,500	32,500
Naugatuck, Conn. (U.S.G.S. Gage)	2.0	30.5	138,000	23.5	88,000	7.0	50,000	67,000	40,500	26,000
Ansonia, Conn. (Maple St. Bridge)	4.0	29.5	148,000	25.5	109,000	4.0	39,000	74,000	52,000	22,000
COMPREHENSIVE PLAN										
Torrington, Conn. (Below East Branch)	3.0	25.5	35,000	20.3	19,600	5.2	15,400	20,000	11,200	8,800
Waterbury, Conn. (West Main St. Bridge)	3.0	31.5	107,000	20.5	40,000	11.0	67,000	60,000	16,000	44,000
Naugatuck, Conn. (U.S.G.S. Gage)	2.0	30.5	138,000	18.5	58,000	12.0	80,000	67,000	25,900	41,100
Ansonia, Conn. (Maple St. Bridge)	4.0	29.5	148,000	22.0	75,000	7.5	73,000	74,000	38,300	35,700

(1) T.T.C.F. used to determine percent reductions for economic studies only. Stage has no meaning.

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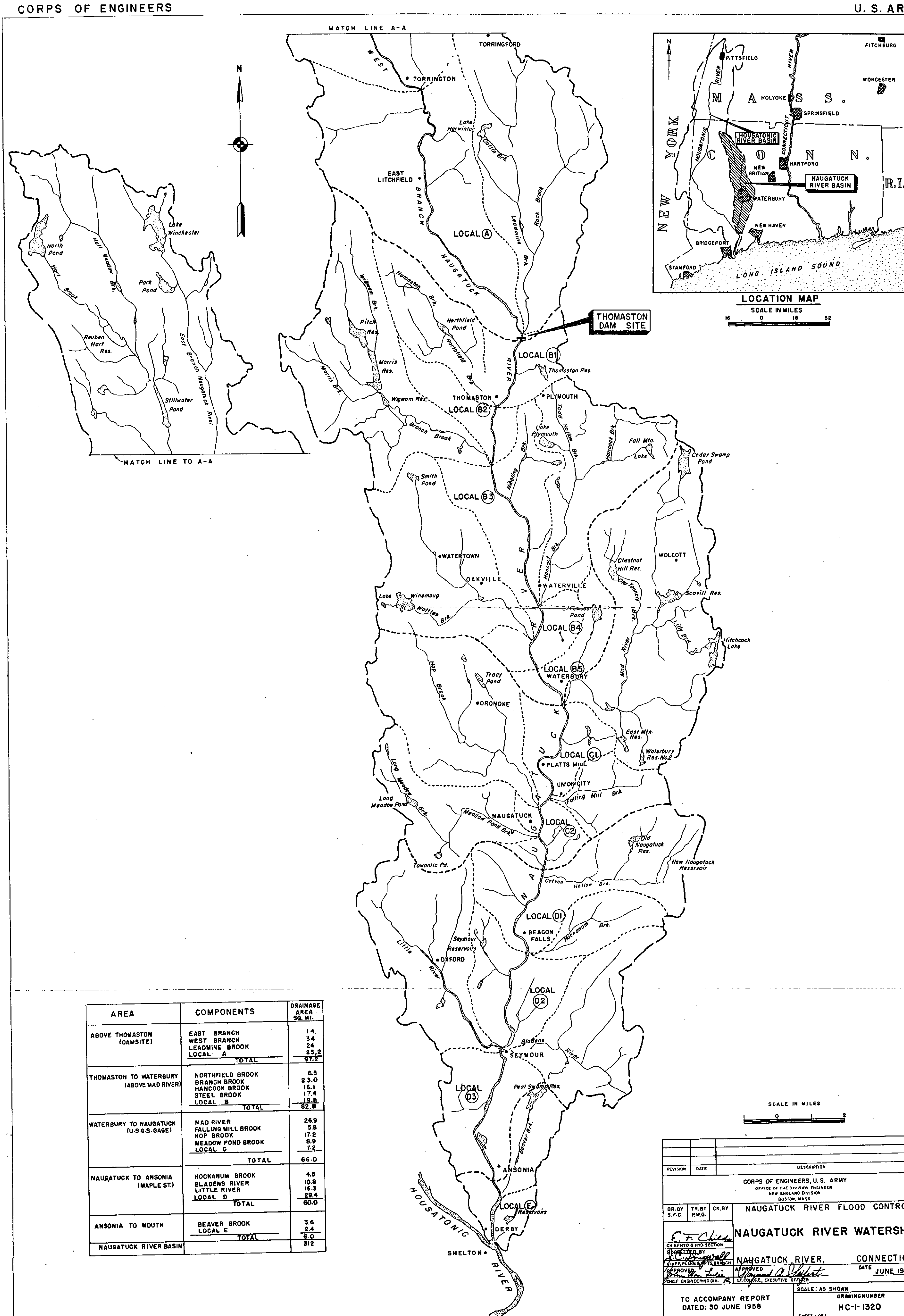

AREA	COMPONENTS	DRAINAGE AREA SQ. MI.
ABOVE THOMASTON (DAMSITE)	EAST BRANCH	14
	WEST BRANCH	34
	LEADMINE BROOK	24
	LOCAL A	25.2
	TOTAL	97.2
THOMASTON TO WATERBURY (ABOVE MAD RIVER)	NORTHFIELD BROOK	6.5
	BRANCH BROOK	23.0
	HANCOCK BROOK	16.1
	STEEL BROOK	17.4
	LOCAL B	19.8
	TOTAL	82.8
WATERBURY TO NAUGATUCK (U.S.G.S. GAGE)	MAD RIVER	26.9
	FALLING MILL BROOK	5.8
	HOP BROOK	17.2
	MEADOW POND BROOK	8.9
	LOCAL C	7.2
	TOTAL	66.0
NAUGATUCK TO ANSONIA (MAPLE ST.)	HOCKANUM BROOK	4.5
	BLADENS RIVER	10.8
	LITTLE RIVER	15.3
	LOCAL D	29.4
	TOTAL	60.0
ANSONIA TO MOUTH	BEAVER BROOK	3.6
	LOCAL E	2.4
	TOTAL	6.0
NAUGATUCK RIVER BASIN		312

REVISION	DATE	DESCRIPTION

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NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY S.F.C. | TR. BY P.W.G. | CK. BY

NAUGATUCK RIVER FLOOD CONTROL

NAUGATUCK RIVER WATERSHED

NAUGATUCK RIVER, CONNECTICUT

E. F. Childs
CHIEF HYD. & HYD. SECTION

SUBMITTED BY
J. C. Dingwall
CHIEF, PLANN. & RPTS. BRANCH

APPROVED
John Wm. Leslie
CHIEF ENGINEERING DIV.

APPROVED
Raymond A. Seifert
LT. COL., C.E., EXECUTIVE OFFICER

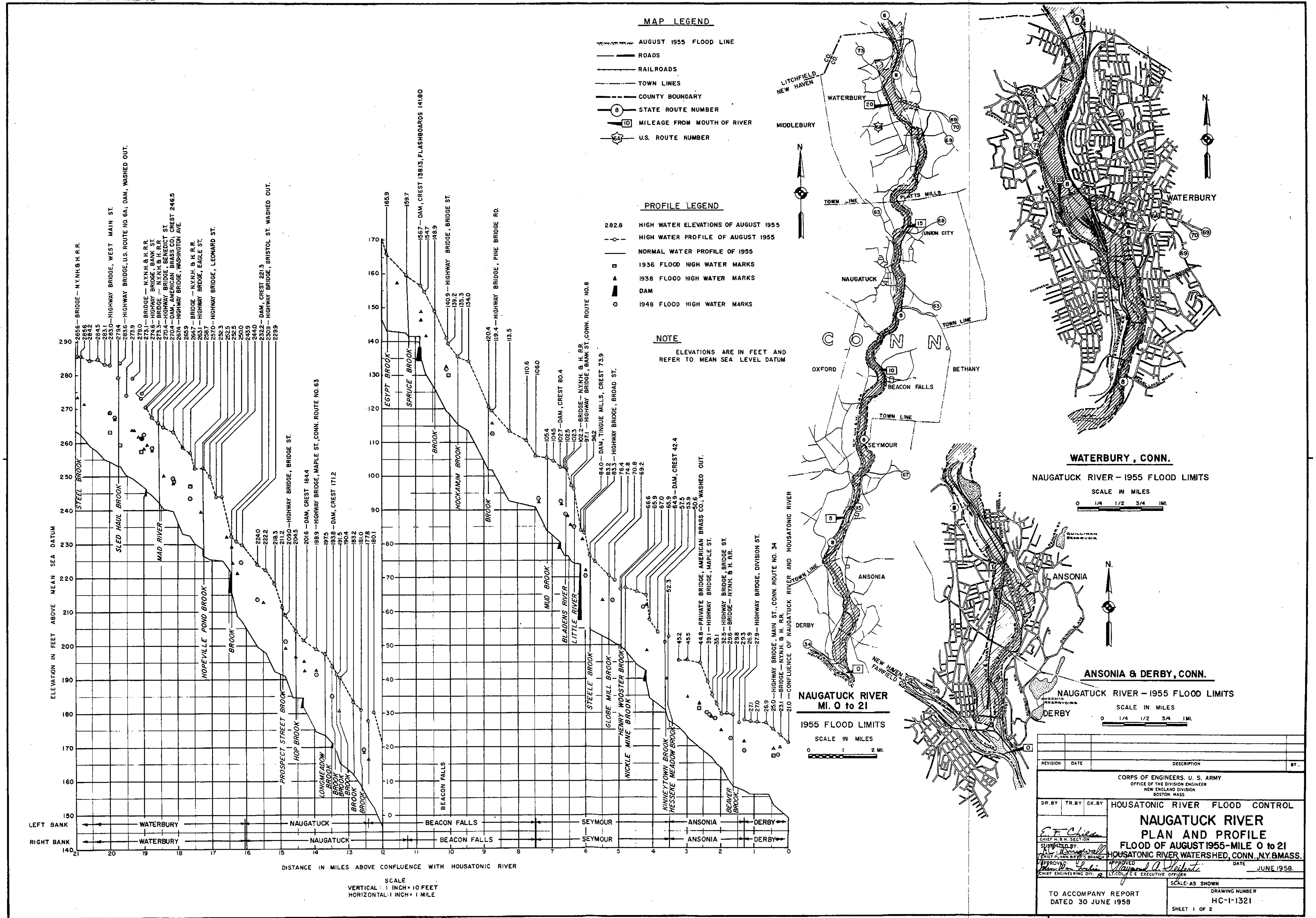
DATE JUNE 1958

SCALE: AS SHOWN

TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

DRAWING NUMBER
HC-1-1320
SHEET 1 OF 1

PLATE NO. B-1


MAP LEGEND
AUGUST 1955 FLOOD LINE
ROADS
RAILROADS
TOWN LINES
COUNTY BOUNDARY
STATE ROUTE NUMBER
MILEAGE FROM MOUTH OF RIVER
U.S. ROUTE NUMBER
PROFILE LEGEND
282.8 HIGH WATER ELEVATIONS OF AUGUST 1955
HIGH WATER PROFILE OF AUGUST 1955
NORMAL WATER PROFILE OF 1955
1936 FLOOD HIGH WATER MARKS
1938 FLOOD HIGH WATER MARKS
DAM
1948 FLOOD HIGH WATER MARKS
NOTE
ELEVATIONS ARE IN FEET AND REFER TO MEAN SEA LEVEL DATUM
ELEVATION IN FEET ABOVE MEAN SEA DATUM
DISTANCE IN MILES ABOVE CONFLUENCE WITH HOUSATONIC RIVER
SCALE
VERTICAL: 1 INCH = 10 FEET
HORIZONTAL: 1 INCH = 1 MILE
LEFT BANK
RIGHT BANK
WATERBURY
NAUGATUCK
BEACON FALLS
SEYMOUR
ANSONIA
DERBY
STEEL BROOK
SLED HAUL BROOK
MAD RIVER
HOPEVILLE POND BROOK
BROOK
PROSPECT STREET BROOK
HOP BROOK
LONGMEADOW BROOK
EGYPT BROOK
SPRUCE BROOK
HOCKANUM BROOK
MUD BROOK
BLADENS RIVER
LITTLE RIVER
STEELE BROOK
GLOBE MILL BROOK
HENRY WOOSTER BROOK
NICKLE MINE BROOK
KINNEYTOWN BROOK
HESSEKE MEADOW BROOK
BEAVER BROOK
NAUGATUCK RIVER
MI. 0 to 21
1955 FLOOD LIMITS
SCALE IN MILES
WATERBURY, CONN.
NAUGATUCK RIVER – 1955 FLOOD LIMITS
SCALE IN MILES
ANSONIA & DERBY, CONN.
NAUGATUCK RIVER – 1955 FLOOD LIMITS
SCALE IN MILES
LITCHFIELD CO.
NEW HAVEN CO.
MIDDLEBURY
WATERBURY
NAUGATUCK
OXFORD
BEACON FALLS
BETHANY
SEYMOUR
ANSONIA
DERBY
UNION CITY
PLATTS MILLS
TOWN LINE
CONN
NEW HAVEN CO.
FAIRFIELD CO.
REVISION
DATE
DESCRIPTION
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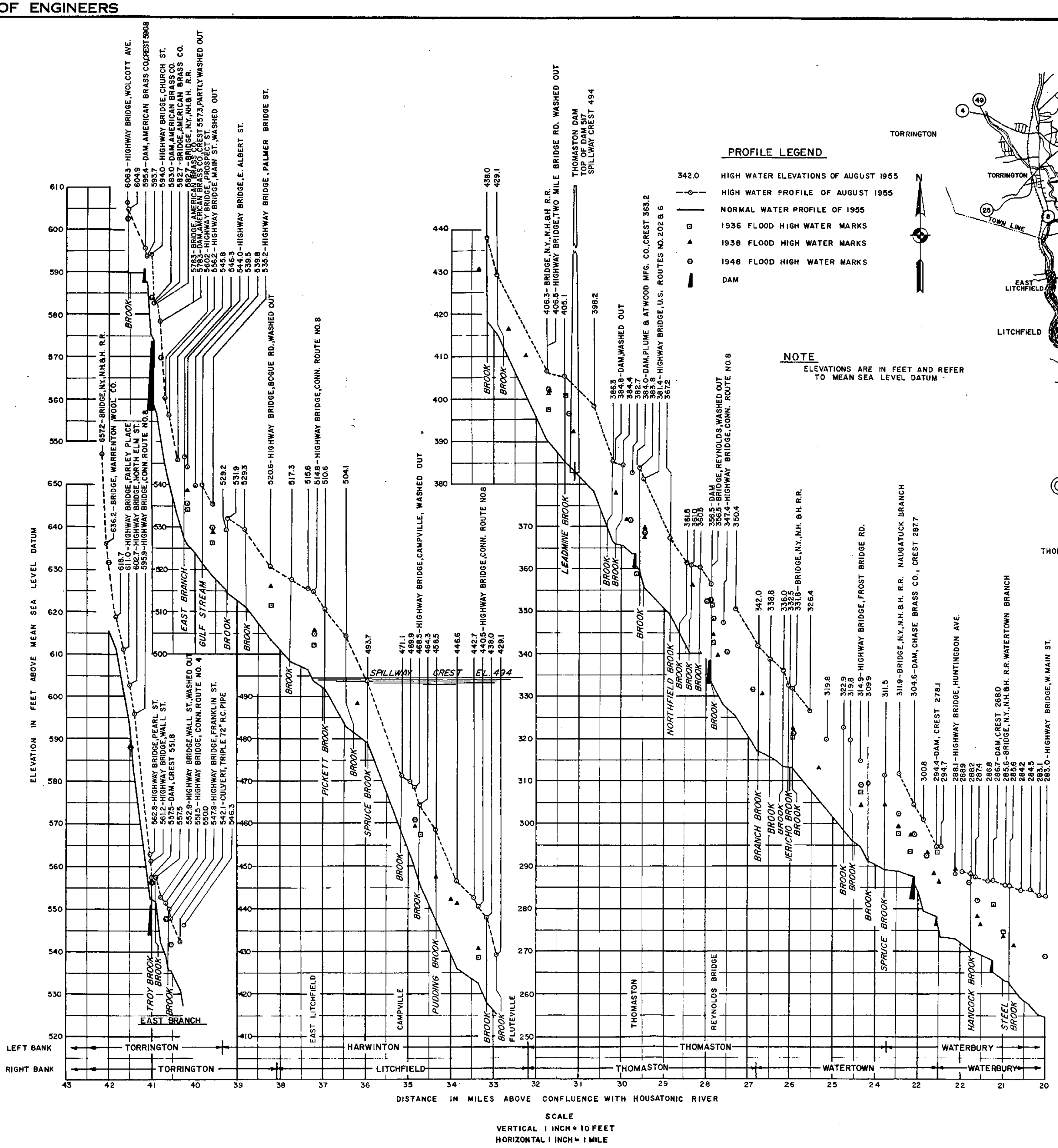
NEW ENGLAND DIVISION
BOSTON, MASS.
DR. BY
TR. BY
CK. BY
HOUSATONIC RIVER FLOOD CONTROL
NAUGATUCK RIVER
PLAN AND PROFILE
FLOOD OF AUGUST 1955 – MILE 0 to 21
HOUSATONIC RIVER WATERSHED, CONN., N.Y. & MASS.
CHIEF, H. & H. SECTION
SUBMITTED BY
CHIEF, PLANNING BRANCH
APPROVED
CHIEF, ENGINEERING DIV.
APPROVED
LT. COL. C.E. EXECUTIVE OFFICER
DATE
JUNE 1958.
SCALE: AS SHOWN
TO ACCOMPANY REPORT
DATED 30 JUNE 1958
DRAWING NUMBER
HC-1-1321
SHEET 1 OF 2

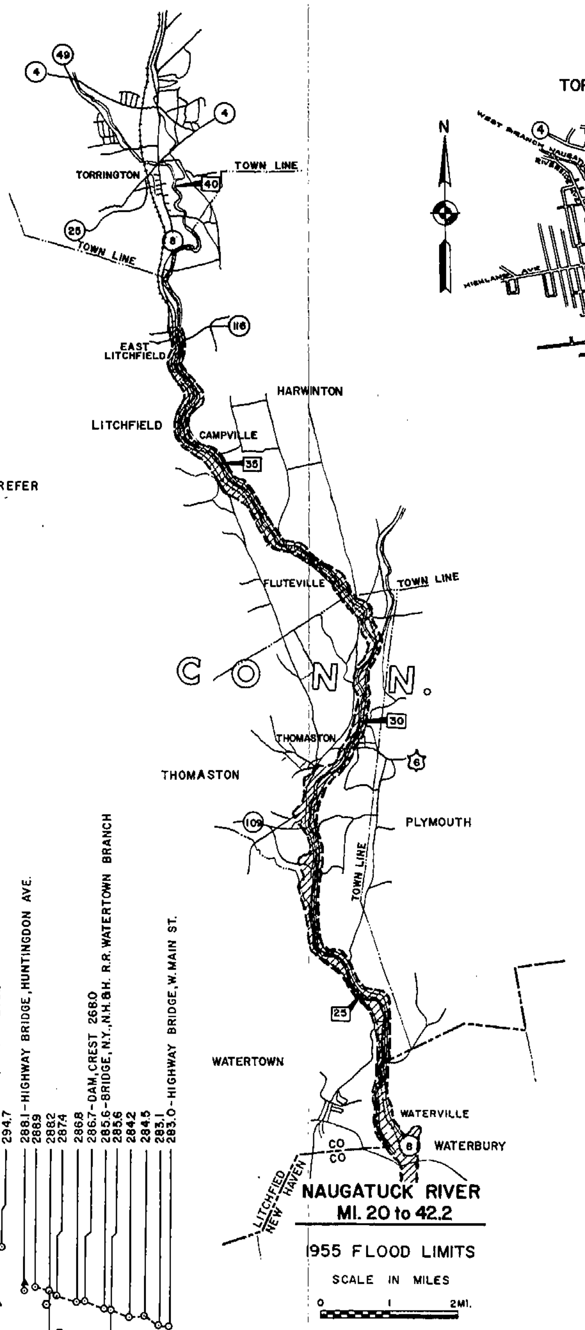


SCALE
VERTICAL 1 INCH = 10 FEET
HORIZONTAL 1 INCH = 1 MILE

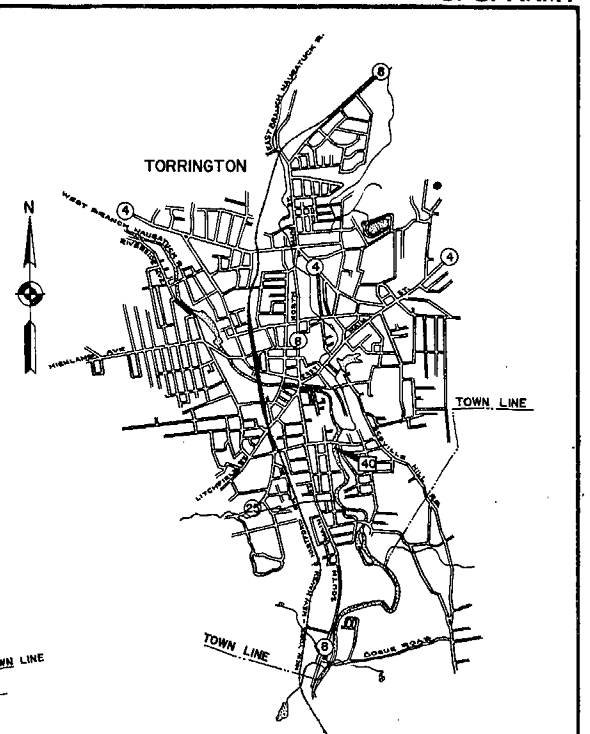
PROFILE LEGEND

342.0 HIGH WATER ELEVATIONS OF AUGUST 1955
HIGH WATER PROFILE OF AUGUST 1955
NORMAL WATER PROFILE OF 1955
1936 FLOOD HIGH WATER MARKS
1938 FLOOD HIGH WATER MARKS
1948 FLOOD HIGH WATER MARKS
DAM

NOTE
ELEVATIONS ARE IN FEET AND REFER TO MEAN SEA LEVEL DATUM



NAUGATUCK RIVER
MI. 20 to 42.2
1955 FLOOD LIMITS
SCALE IN MILES



TORRINGTON, CONN.
NAUGATUCK RIVER – 1955 FLOOD LIMITS
SCALE IN MILES

MAP LEGEND

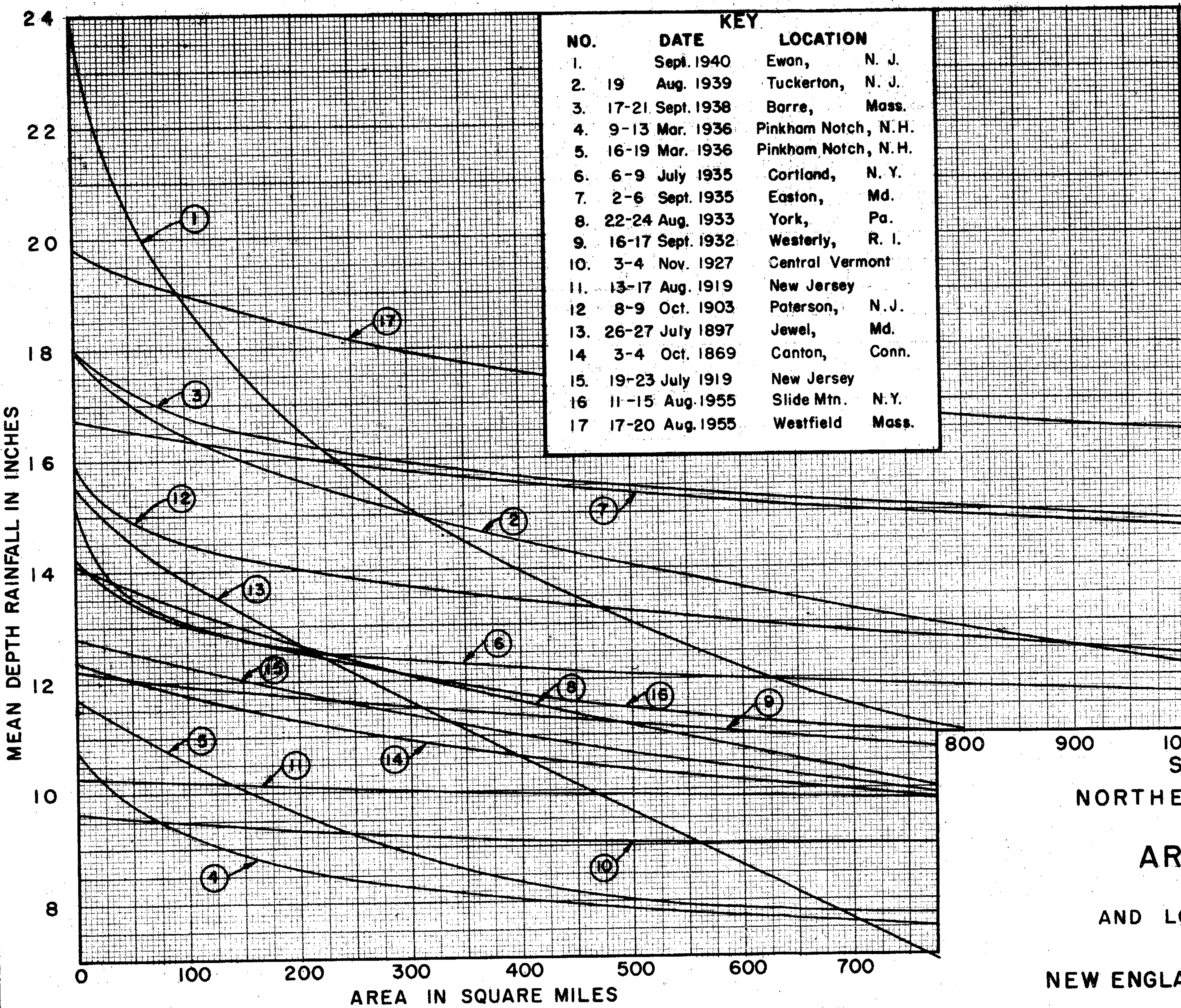
AUGUST 1955 FLOOD LINE
ROADS
RAILROADS
TOWN LINES
COUNTY BOUNDARY
STATE ROUTE NUMBER
MILEAGE FROM MOUTH OF RIVER
U.S. ROUTE NUMBER

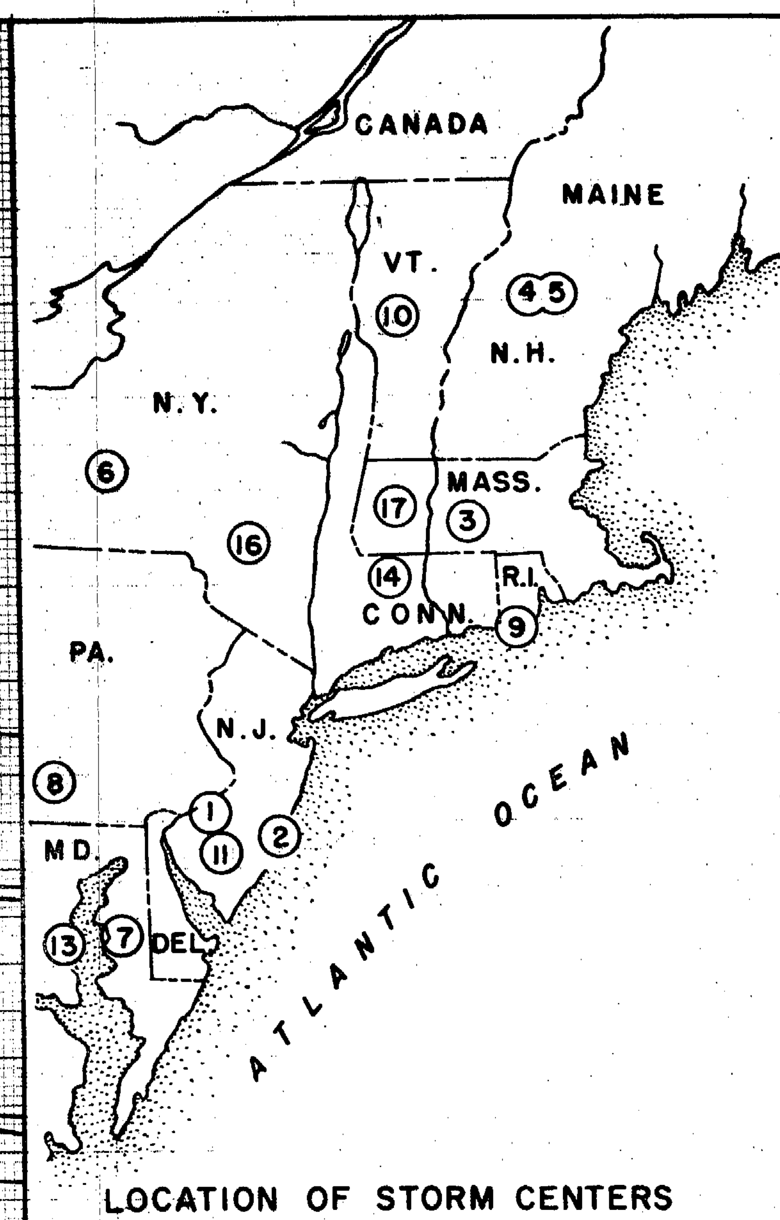
REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

HOUSATONIC RIVER FLOOD CONTROL
NAUGATUCK RIVER
PLAN AND PROFILE
FLOOD OF AUGUST 1955 - MILE 20 to 42.2
HOUSATONIC RIVER WATERSHED, CONN., NY. & MASS.

DR. BY | TR. BY | CK. BY
CHIEF H & H SECTION
SUBMITTED BY
CHIEF PLAN & REP'TS BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
LT. COL. C E EXECUTIVE OFFICER
DATE JUNE 1958
SCALE: AS SHOWN
TO ACCOMPANY REPORT DATED: 30 JUNE 1958
DRAWING NUMBER HC-1-1322
SHEET 2 OF 2





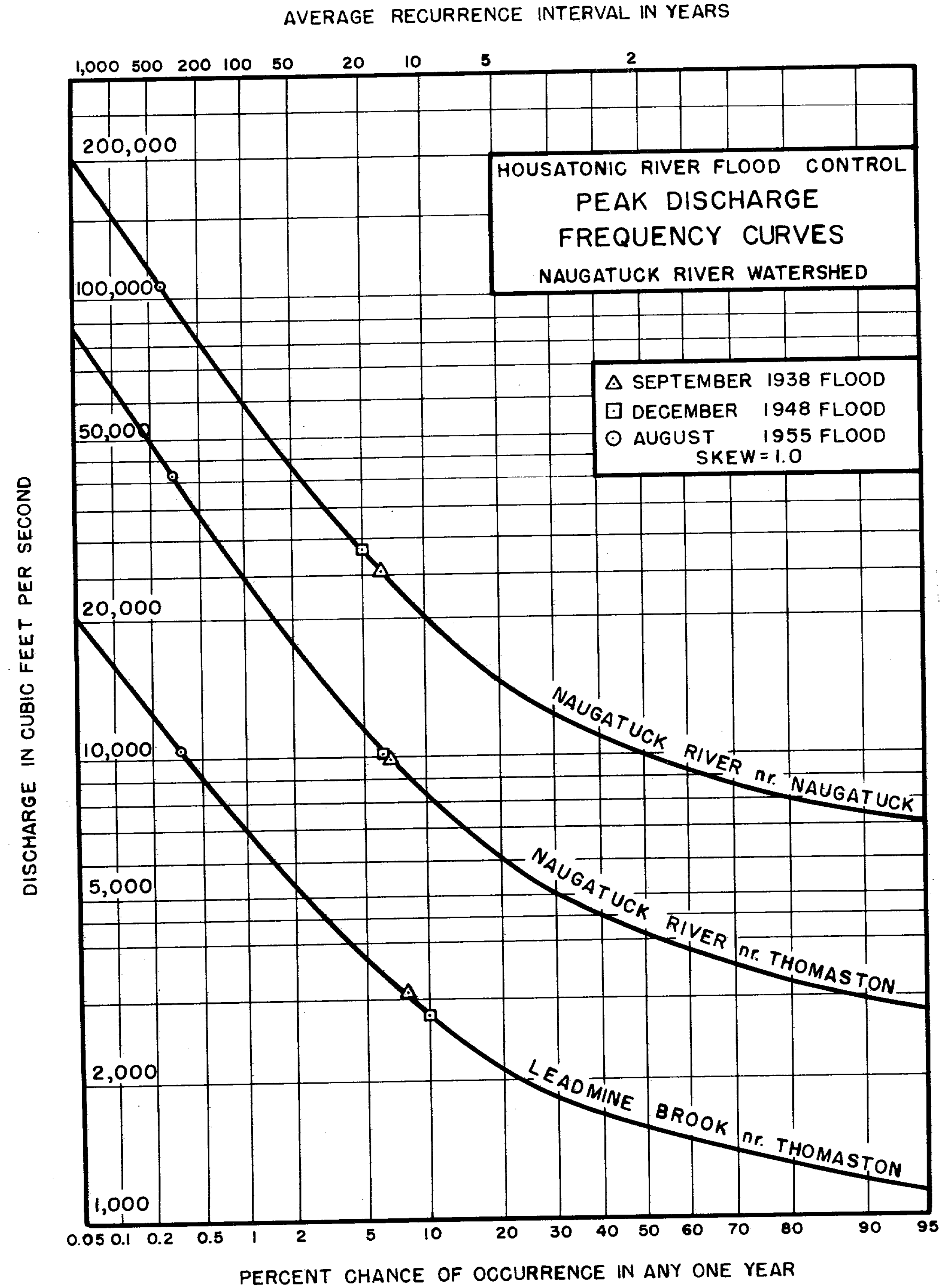
STORMS OF RECORD
NORTHEASTERN UNITED STATES

AREA-DEPTH CURVES

AND LOCATION OF STORM CENTERS

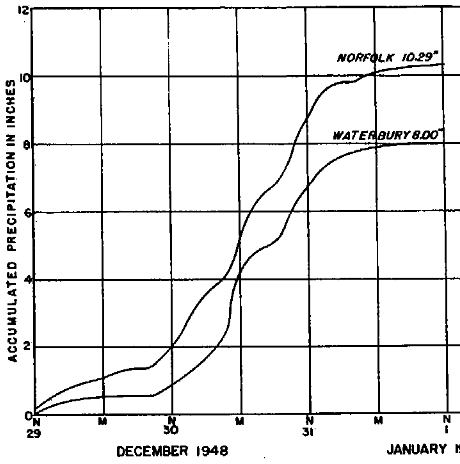
NEW ENGLAND DIVISION BOSTON, MASS.
NOVEMBER 1956

PLATE NO. B-4

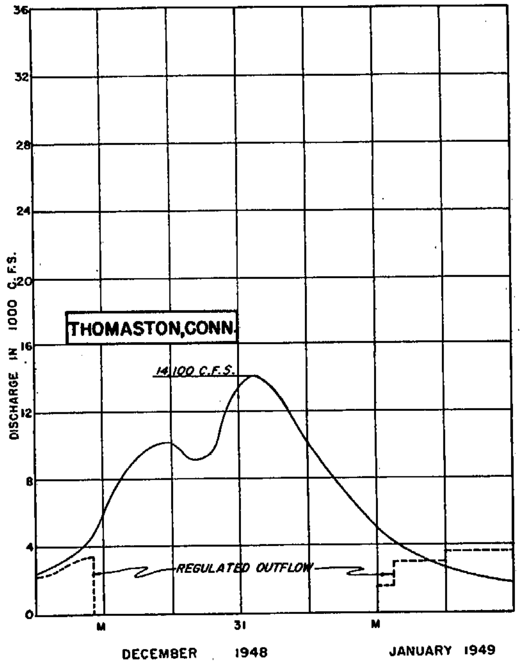


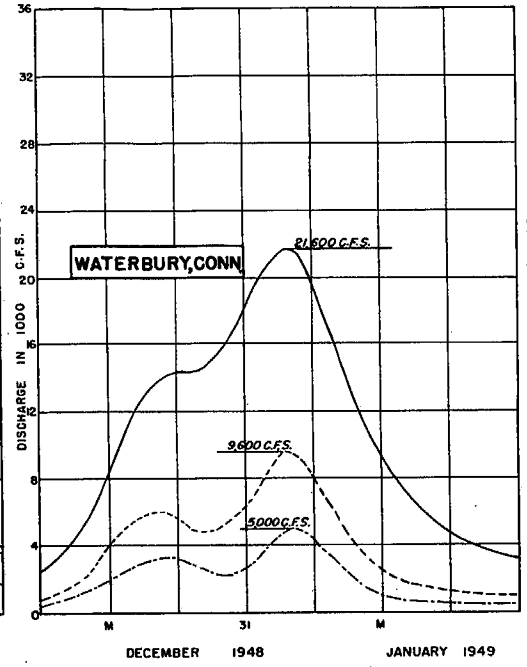
AVERAGE RECURRENCE INTERVAL IN YEARS
1,000 500 200 100 50 20 10 5 2
HOUSATONIC RIVER FLOOD CONTROL
PEAK DISCHARGE
FREQUENCY CURVES
NAUGATUCK RIVER WATERSHED
△ SEPTEMBER 1938 FLOOD
⊡ DECEMBER 1948 FLOOD
⊙ AUGUST 1955 FLOOD
SKEW = 1.0
200,000
100,000
50,000
20,000
10,000
5,000
2,000
1,000
DISCHARGE IN CUBIC FEET PER SECOND
NAUGATUCK RIVER nr. NAUGATUCK
NAUGATUCK RIVER nr. THOMASTON
LEADMINE BROOK nr. THOMASTON
0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95
PERCENT CHANCE OF OCCURRENCE IN ANY ONE YEAR

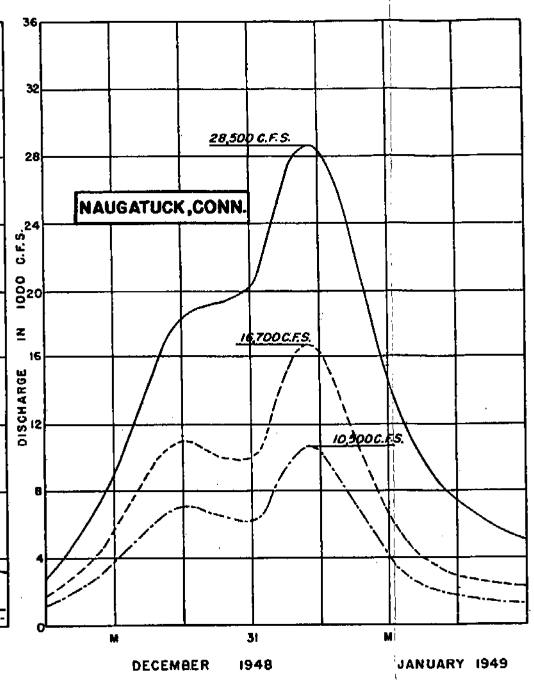
PLATE NO. B-5

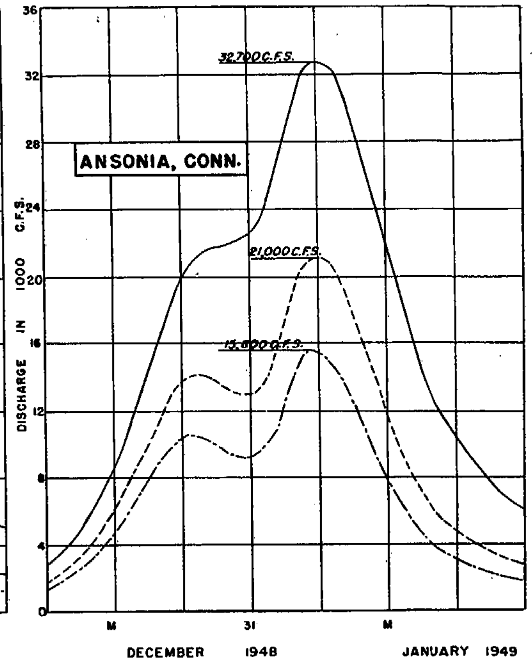


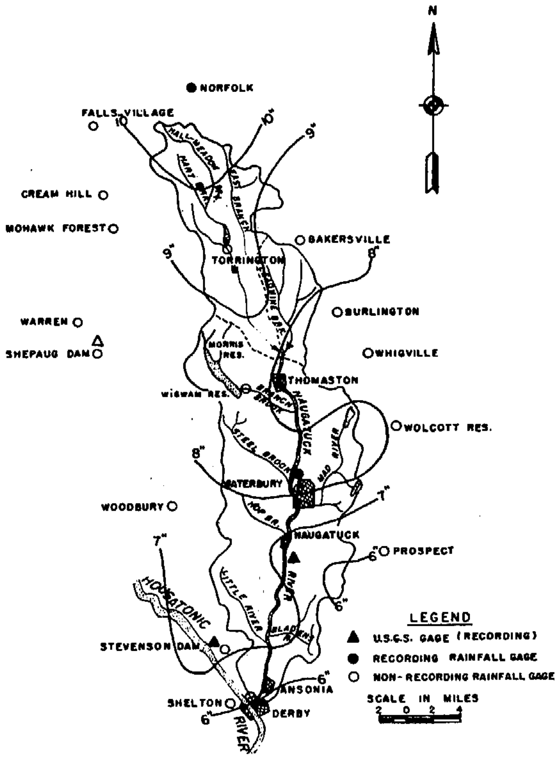
MASS CURVE OF RAINFALL







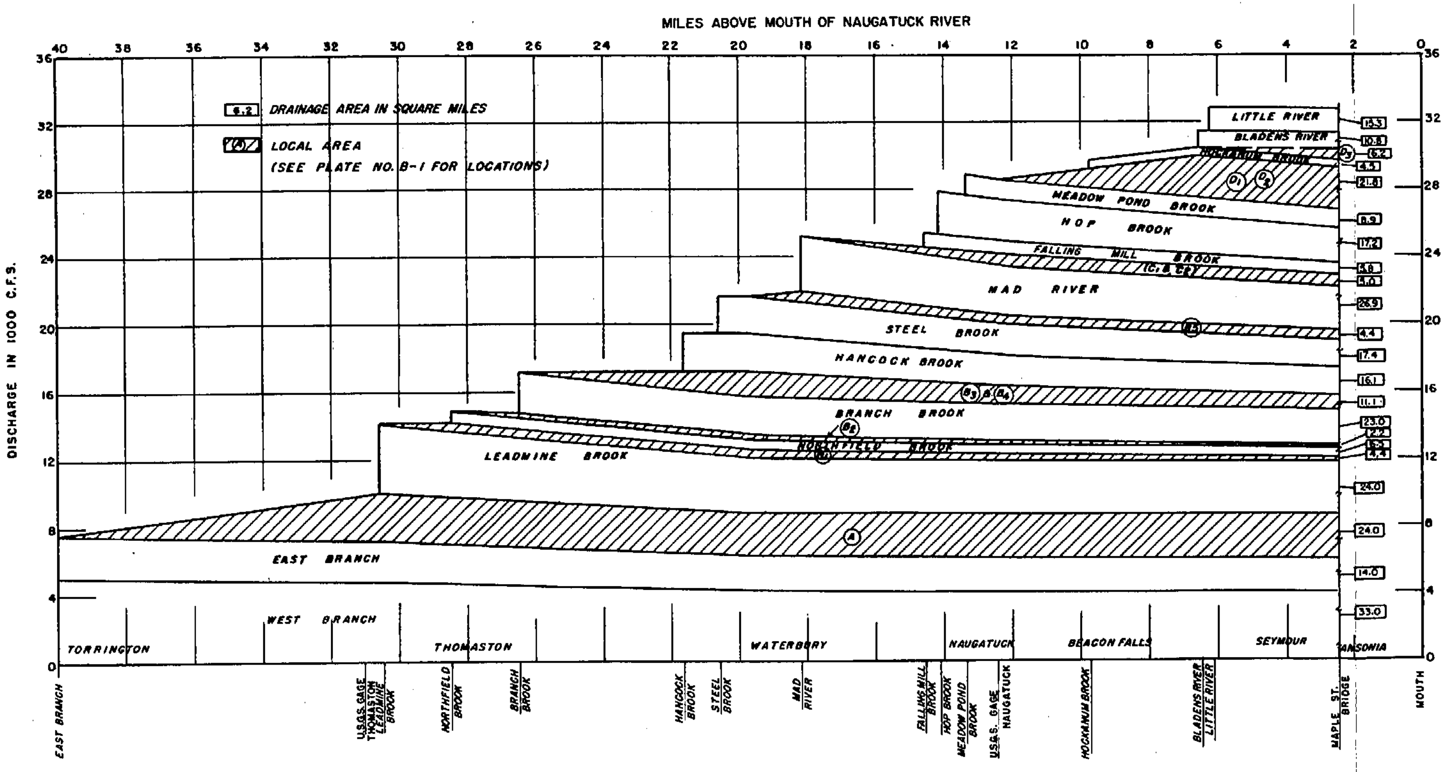




ISOHYETAL MAP

STORM OF DECEMBER 1948

NAUGATUCK RIVER BASIN



PEAK DISCHARGE PROFILE AND TRIBUTARY CONTRIBUTIONS

LEGEND

- 6.2 DRAINAGE AREA IN SQ. MI.
- O_1 AREAL SUB-DIVISION
- (A) LOCAL AREA
- ——— NATURAL
- — — — MODIFIED BY THOMASTON RESERVOIR (APPLICABLE FOR THOMASTON, HALL MEADOW BROOK, AND EAST BRANCH RESERVOIRS)
- —·—·— MODIFIED BY COMPREHENSIVE SYSTEM OF RESERVOIRS:
  - THOMASTON RESERVOIR (PLUS HALL MEADOW BROOK AND EAST BRANCH RESERVOIRS)
  - NORTHFIELD BROOK RESERVOIR
  - BLACK ROCK RESERVOIR
  - HANCOCK BROOK RESERVOIR
  - HOP BROOK RESERVOIR

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY	TR. BY	CK. BY
A.P.M.	P.W.G.	

HOUSATONIC RIVER FLOOD CONTROL

FLOOD OF DECEMBER 1948

NAUGATUCK RIVER WATERSHED, CONNECTICUT.

E. F. Childs
CHIEF, HYD. & HYD. SECTION
SUBMITTED BY
CHIEF, PLANS & REPTS. BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED Raymond A. Plafnut
LT. COL. CE EXECUTIVE OFFICER

DATE JUNE 1958.

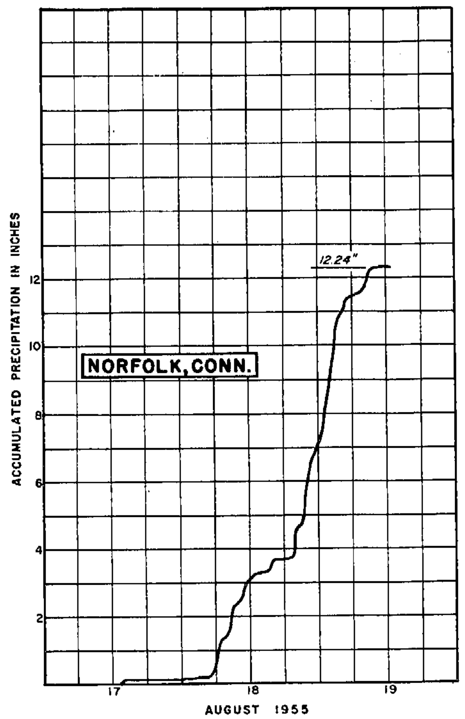
SCALE AS SHOWN

TO ACCOMPANY REPORT DATED: 30 JUNE 1958

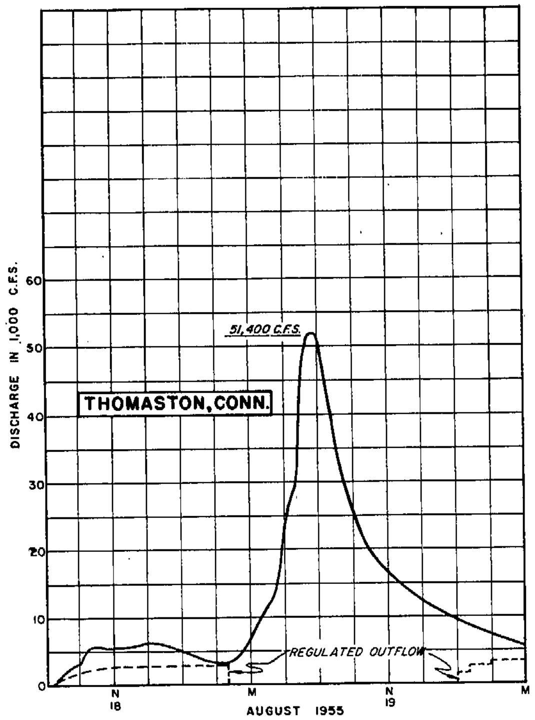
DRAWING NUMBER HC-1-1325

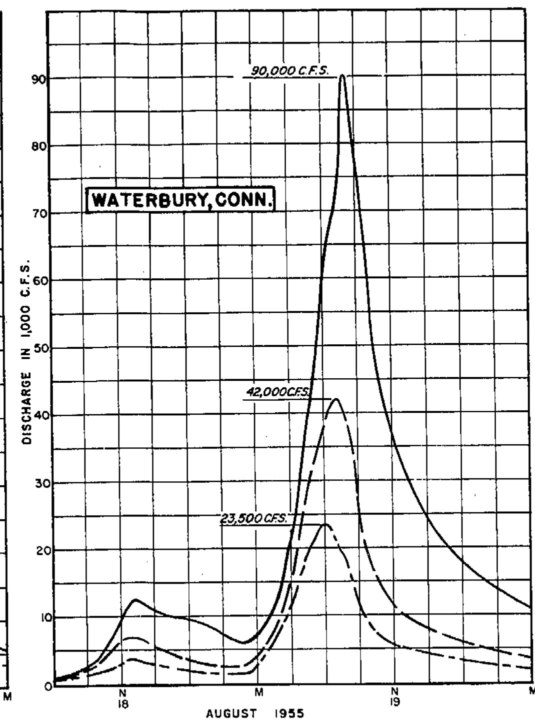
SHEET 1 OF 1

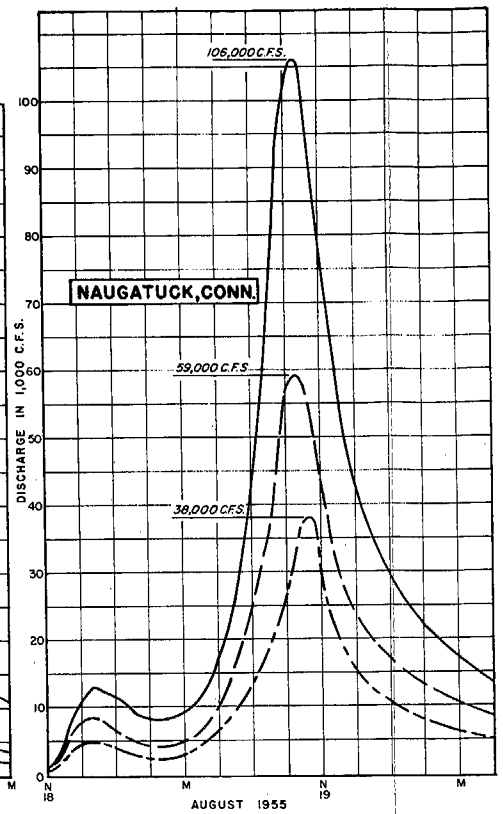
PLATE NO. B-6.

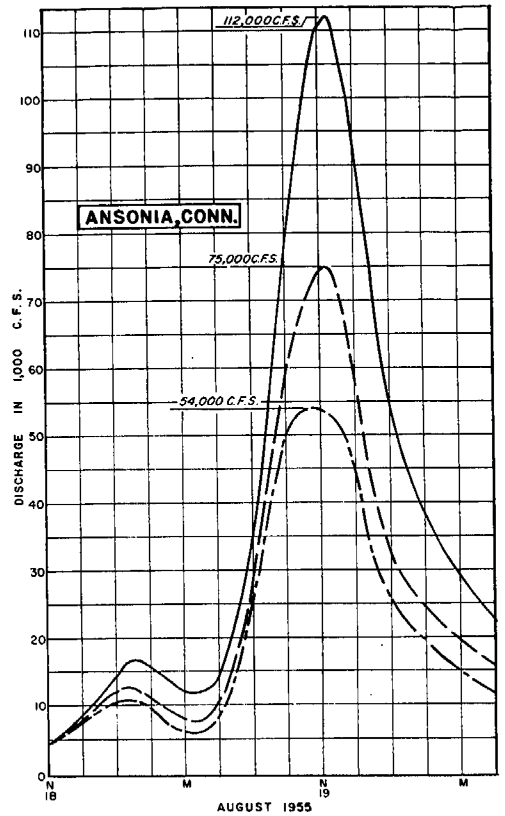


MASS. CURVE OF RAINFALL





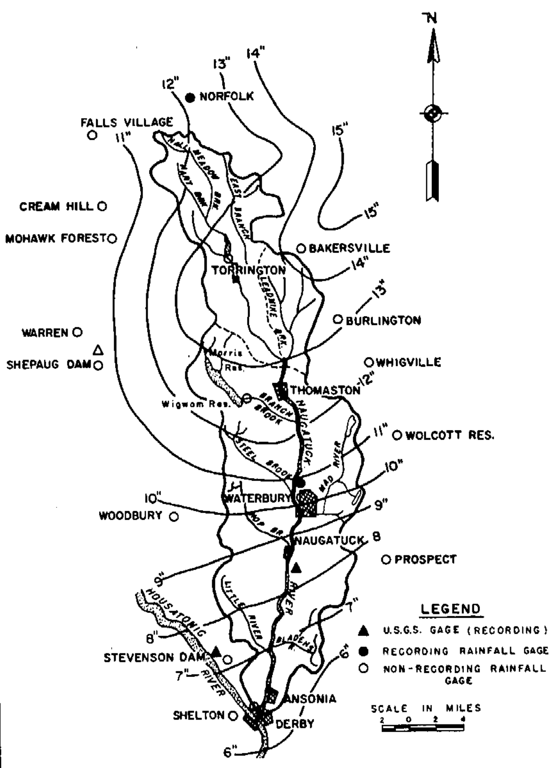




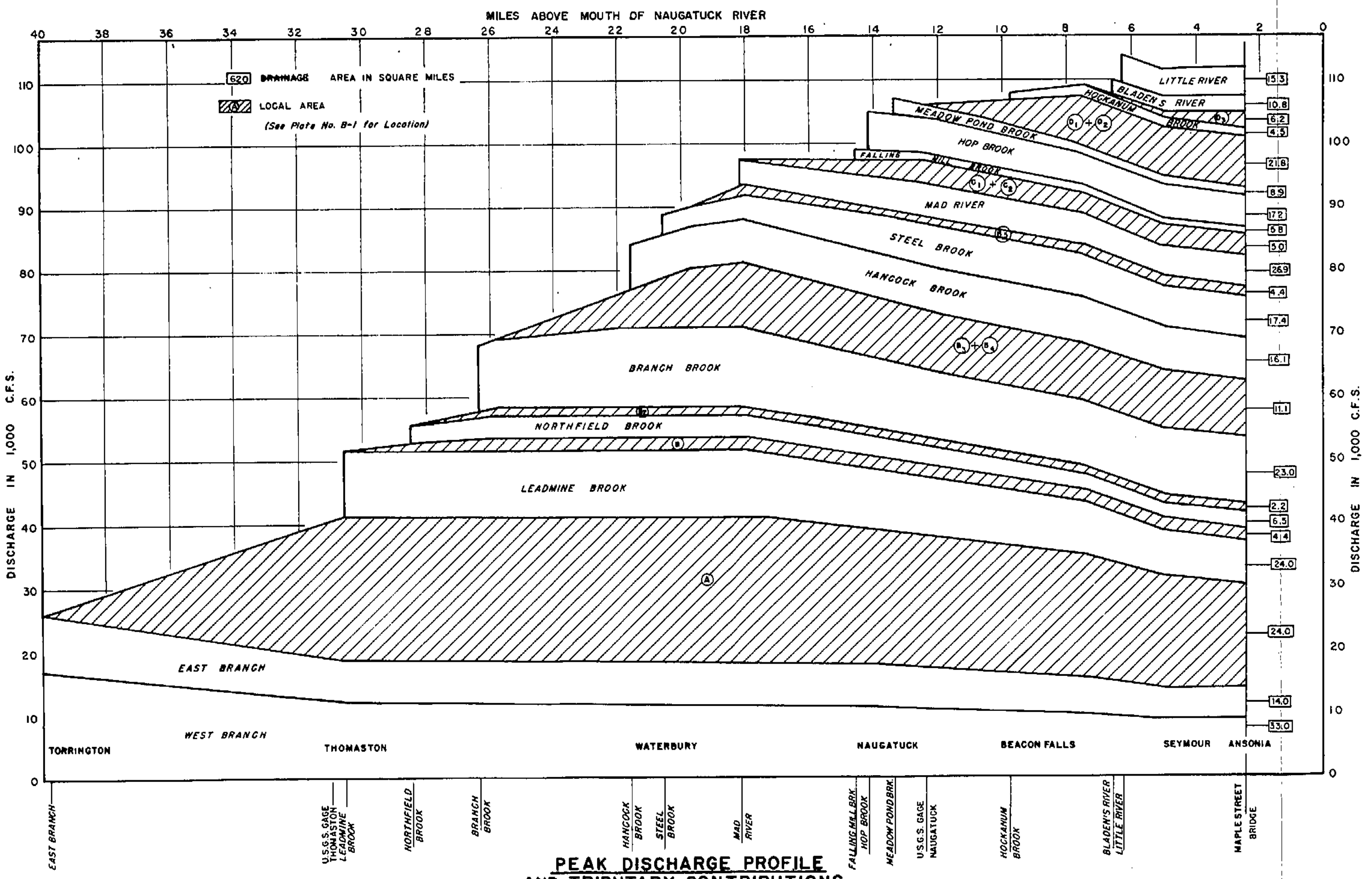
NATURAL

MODIFIED BY THOMASTON RESERVOIR (ALSO APPLICABLE FOR THOMASTON, HALL MEADOW BROOK AND EAST BRANCH RESERVOIRS)

MODIFIED BY COMPREHENSIVE SYSTEM OF RESERVOIRS: THOMASTON RESERVOIR: (PLUS HALL MEADOW BROOK AND EAST BRANCH RESERVOIRS) NORTHFIELD BROOK RESERVOIR. BLACK ROCK RESERVOIR. HOP BROOK RESERVOIR.



ISOHYETAL MAP
STORM OF AUGUST 17-19, 1955
NAUGATUCK RIVER BASIN



PEAK DISCHARGE PROFILE AND TRIBUTARY CONTRIBUTIONS

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY A.P.M. | TR. BY M.W.B. | CK. BY

HOUSATONIC RIVER FLOOD CONTROL

FLOOD OF AUGUST 1955

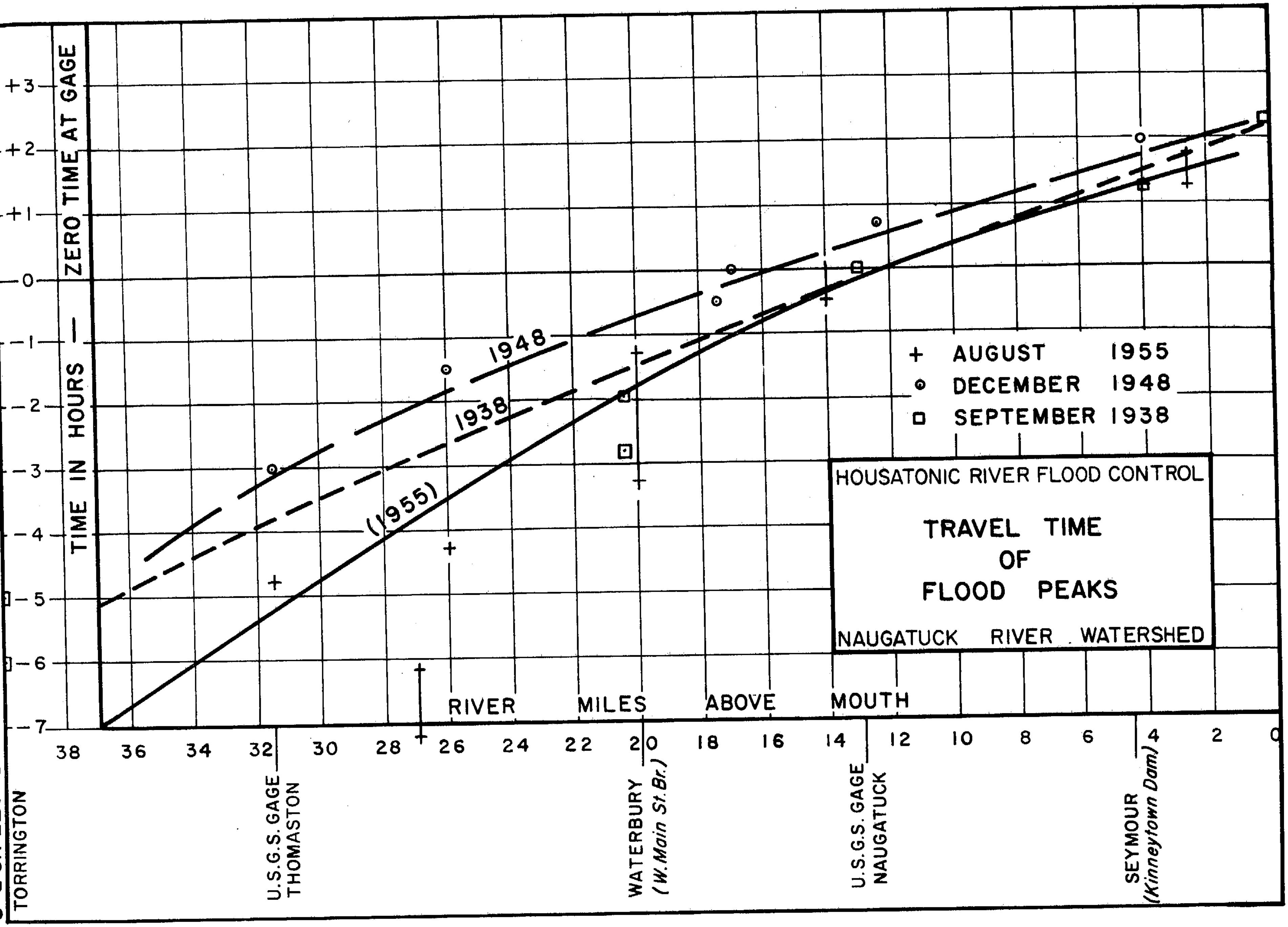
NAUGATUCK RIVER WATERSHED, CONNECTICUT

E. F. Chiles — CHIEF, HYD. & HYD. SECTION
SUBMITTED BY — CHIEF, PLANN. & R.[illegible] BRANCH
APPROVED: — CHIEF ENGINEERING DIV.
APPROVED Raymond A. [illegible] — LT. COL. C.E. EXECUTIVE OFFICER
DATE JUNE, 1958
SCALE AS NOTED

TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

DRAWING NUMBER HC-1-1326
SHEET 1 OF 1

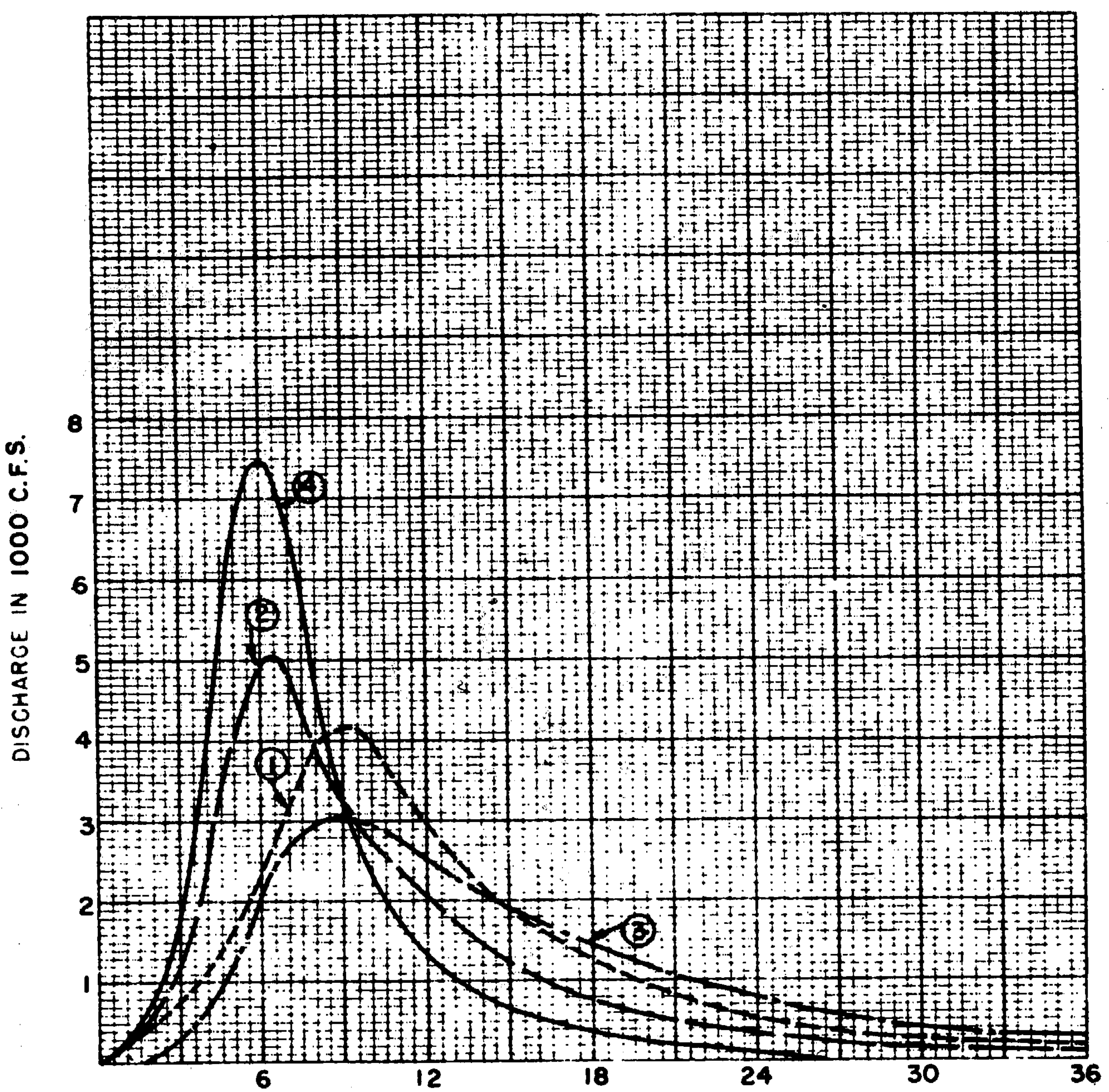
PLATE NO. B-7



HOUSATONIC RIVER FLOOD CONTROL
TRAVEL TIME OF FLOOD PEAKS
NAUGATUCK RIVER WATERSHED
+ AUGUST 1955
⊙ DECEMBER 1948
□ SEPTEMBER 1938
1948
1938
(1955)
TIME IN HOURS — ZERO TIME AT GAGE
+3
+2
+1
0
-1
-2
-3
-4
-5
-6
-7
RIVER MILES ABOVE MOUTH
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
TORRINGTON
U.S.G.S. GAGE THOMASTON
WATERBURY (W. Main St. Br.)
U.S.G.S. GAGE NAUGATUCK
SEYMOUR (Kinneytown Dam)

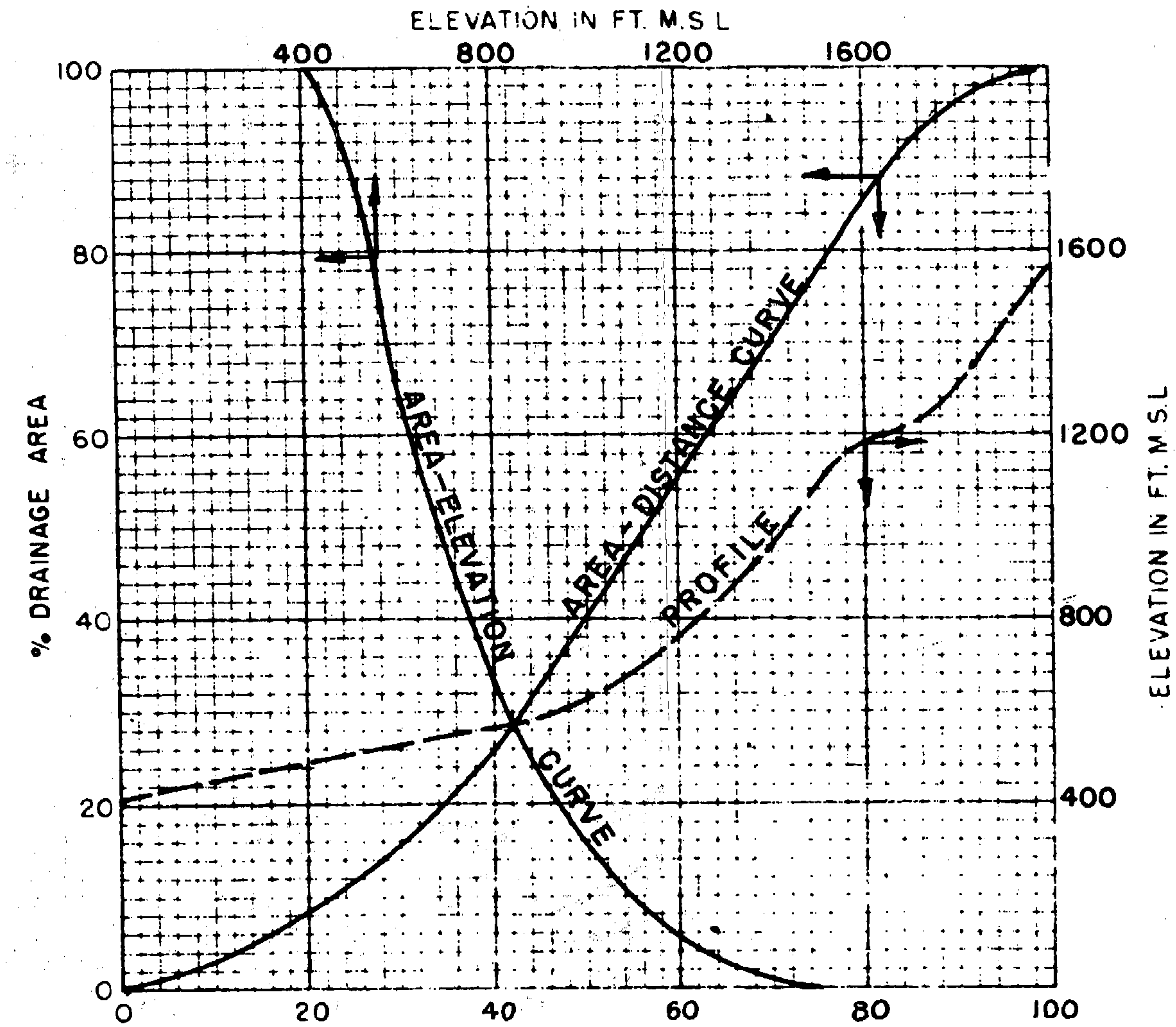
PLATE NO. B-8

OBSERVED UNIT HYDROGRAPHS



DRAINAGE AREA CHARACTERISTICS

DRAINAGE AREA 71.9	sq. mi.	L	19	mi.
MAXIMUM ELEVATION 1550	ft m s l.	L_{ca}	9	mi.
MINIMUM ELEVATION 405	ft. m s. l	$(LL_{ca})^{0.3}$	4.67	
MEAN ELEVATION (weighted) 680	ft. m s l.	DRAINAGE DENSITY		mi/sq. mi
LAND SLOPE	ft./mi	MAP SCALE		
MAIN STREAM SLOPE 27.4	ft./mi	METHOD OF FLOW SEPARATION		
		BASIN SHAPE FACTOR		



DATA FROM OBSERVED UNIT HYDROGRAPHS

DATE OF RAINFALL	LEGEND	AVE. P (in.)	RAINFALL EXCESS DURATION (hr.)	RAINFALL EXCESS AMOUNT (in.)	L_{cP} (mi)	STAGE RECORD	Q_{pR} (cfs.)	Q_p tr= hrs. (cfs.)	t_{pR} (hr.)	t_p (hr)	t_v (hr.)	C_{tR}	C_p640	K_m (hr)	T_c (hr)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
SEPT. 1938	-----1	6.71	3	1.56		REC.	4145	4145	6.33	7.5	8.3	1.36	365		
NEW YEAR 1949	———2	8.15	6	1.75		REC.	3810	5070	5.0	4.0	8.0	1.16	265		
JUNE 1952	——--3	3.47	3	0.67		REC.	3060	3060	6.0	7.5	10.5	1.28	252		
AUGUST 1955	———4	13.3	6	5.6		REC.	5440	7500	4.5	3.0	6.3	0.96	340		

HOUSATONIC RIVER FLOOD CONTROL

NAUGATUCK RIVER BASIN

UNIT HYDROGRAPHS

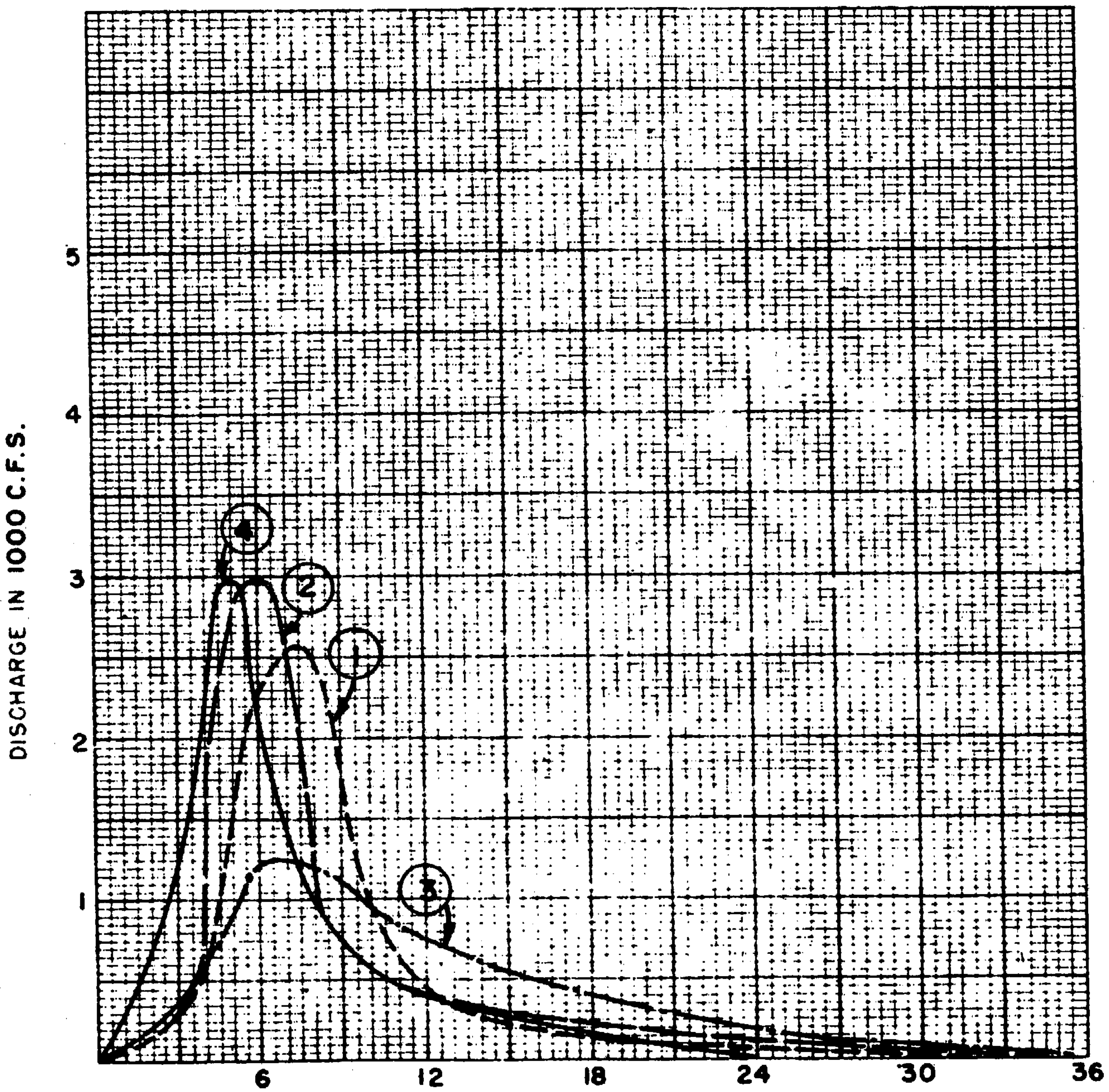
NAUGATUCK RIVER NEAR THOMASTON, CONN.

PERTINENT DATA

NEW ENGLAND DIVISION BOSTON, MASS.

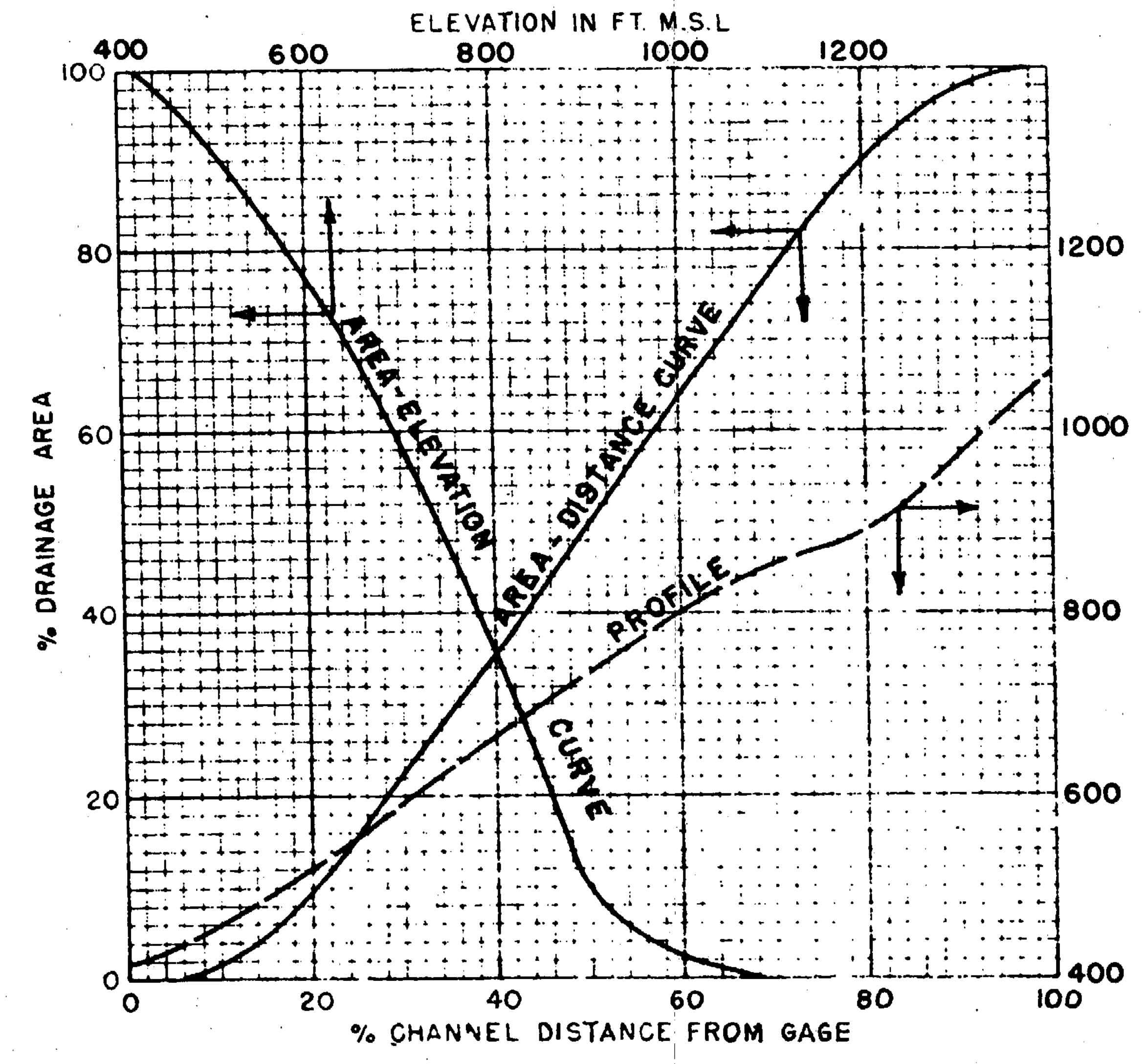
DECEMBER 1956

OBSERVED UNIT HYDROGRAPHS



DRAINAGE AREA CHARACTERISTICS

DRAINAGE AREA 24	sq mi	L	11 mi	
MAXIMUM ELEVATION 1070	ft m.s.l.	L_{co}	5.2 mi	
MINIMUM ELEVATION 420	ft m.s.l.	$(L L_{co})^{0.3}$	3.37	
MEAN ELEVATION (weighted) 740	ft m.s.l.	DRAINAGE DENSITY		mi/sq.mi
LAND SLOPE	ft/mi	MAP SCALE		
MAIN STREAM SLOPE 54	ft/mi	METHOD OF FLOW SEPARATION		
		BASIN SHAPE FACTOR		



DATA FROM OBSERVED UNIT HYDROGRAPHS

DATE OF RAINFALL	LEGEND	AVE. P (In.)	RAINFALL EXCESS DURATION (hr.)	RAINFALL EXCESS AMOUNT (In.)	L_{cP} (mi.)	STAGE RECORD	Q_{pR} (cfs.)	Q_p tr= hrs (cfs)	t_{pR} (hr.)	t_p (hr.)	t_v (hr)	C_{tR}	C_p640	K_m (hr)	T_c (hr)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
SEPT. 1938	----- 1	202	3	1.83			2550	2550	4.95	6.0	5.3	1.47	525		
NEW YEAR 1949	— — 2	1.81	6	1.47			2850	3000	2.99	3.0	5.4	0.89	356		
JUNE 1952	—·— 3	3.47	3	0.46			1161	1250	5	5.5	8.0	1.50	242		
AUGUST 1955	—— 4	13.5	6	3.48			2315	3000	3.79	2.0	3.5	1.12	366		

HOUSATONIC RIVER FLOOD CONTROL

NAUGATUCK RIVER BASIN

UNIT HYDROGRAPHS

LEADMINE BROOK NEAR THOMASTON, CONN.

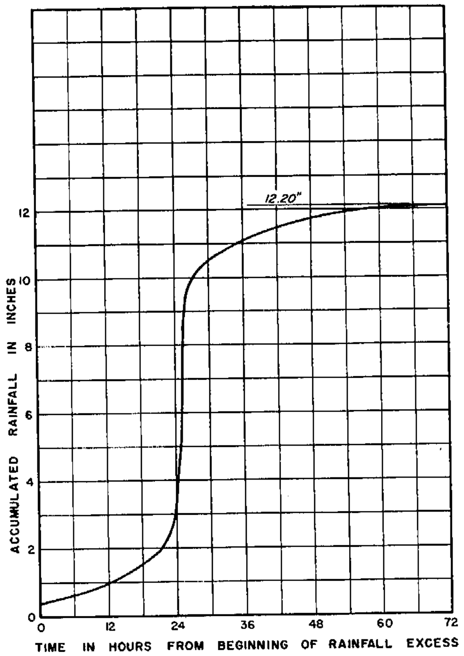
PERTINENT DATA

NEW ENGLAND DIVISION BOSTON, MASS.

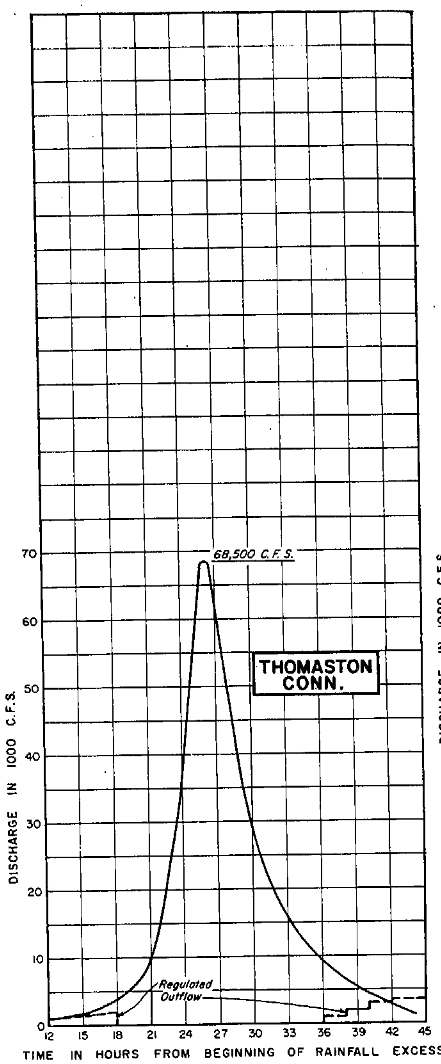
DECEMBER 1956

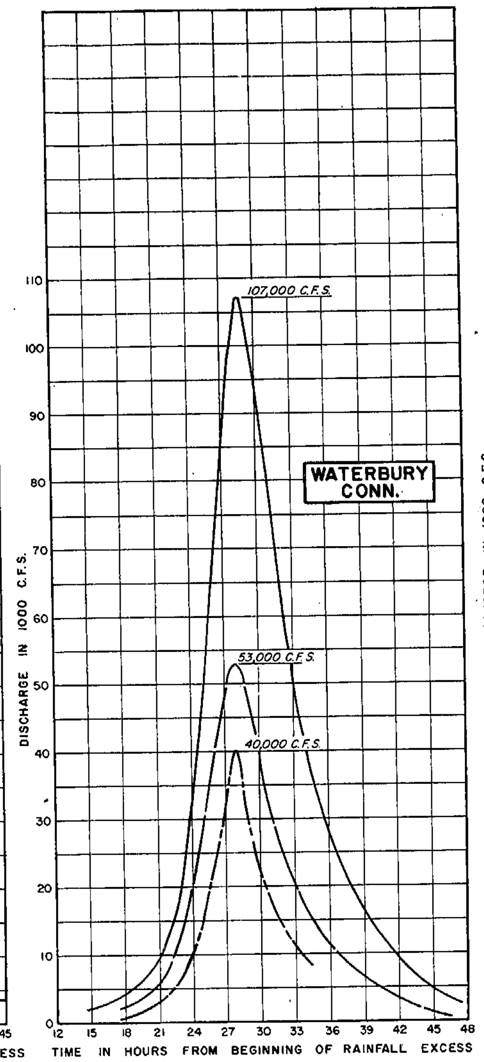
CORPS OF ENGINEERS

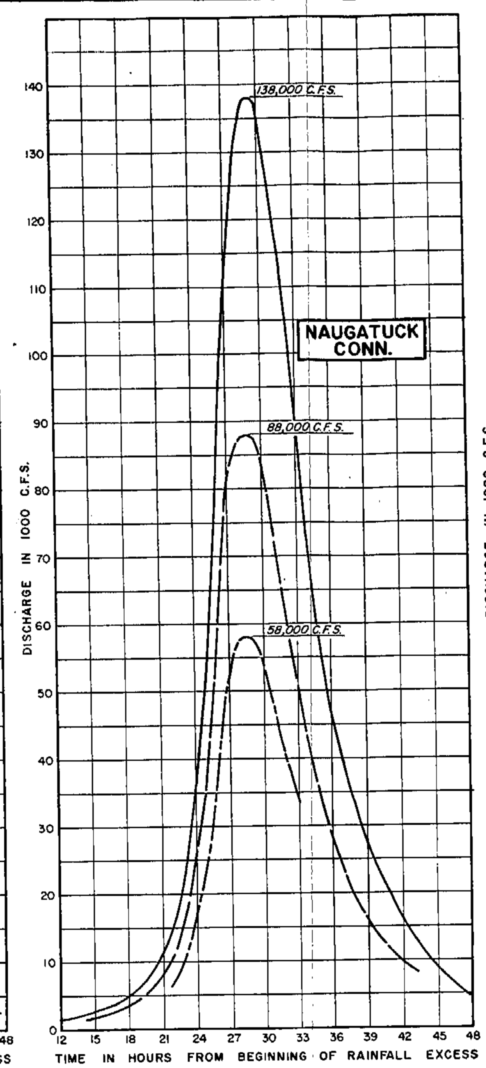
U. S. ARMY

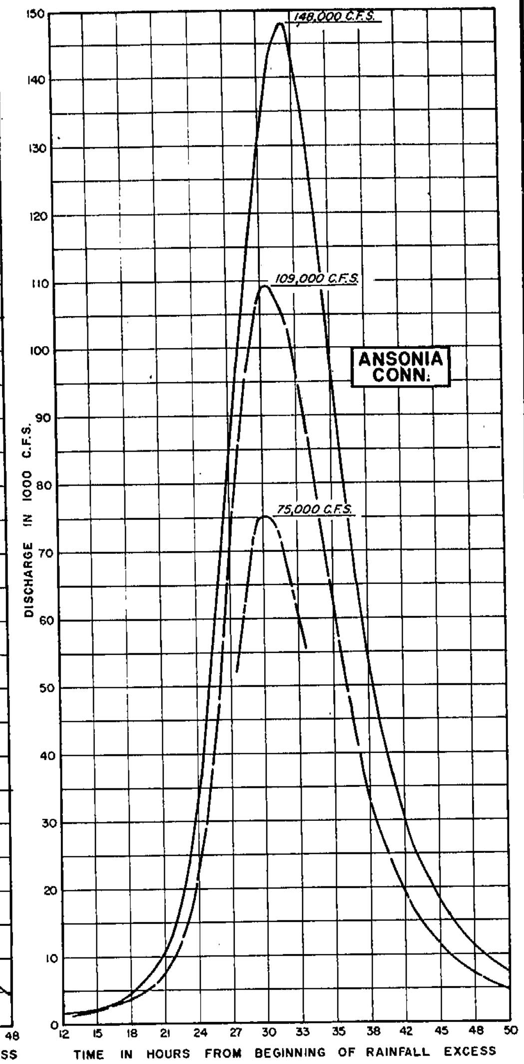


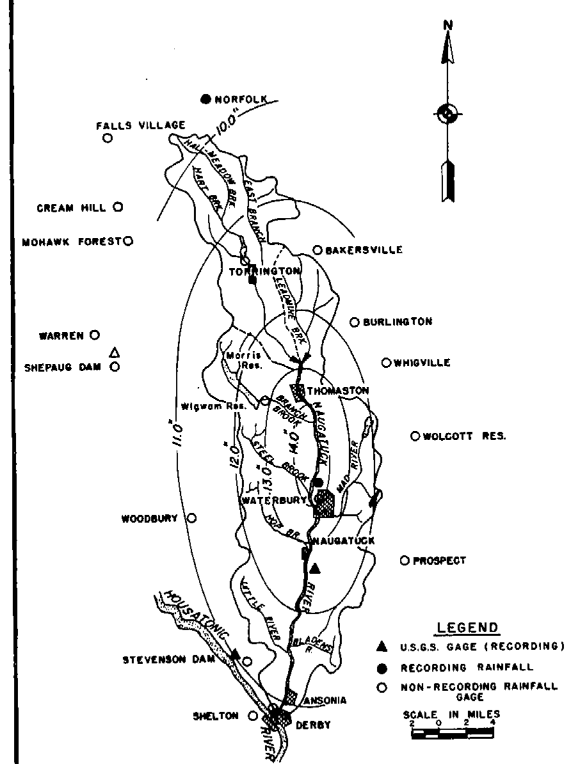
TYPICAL MASS RAINFALL CURVE



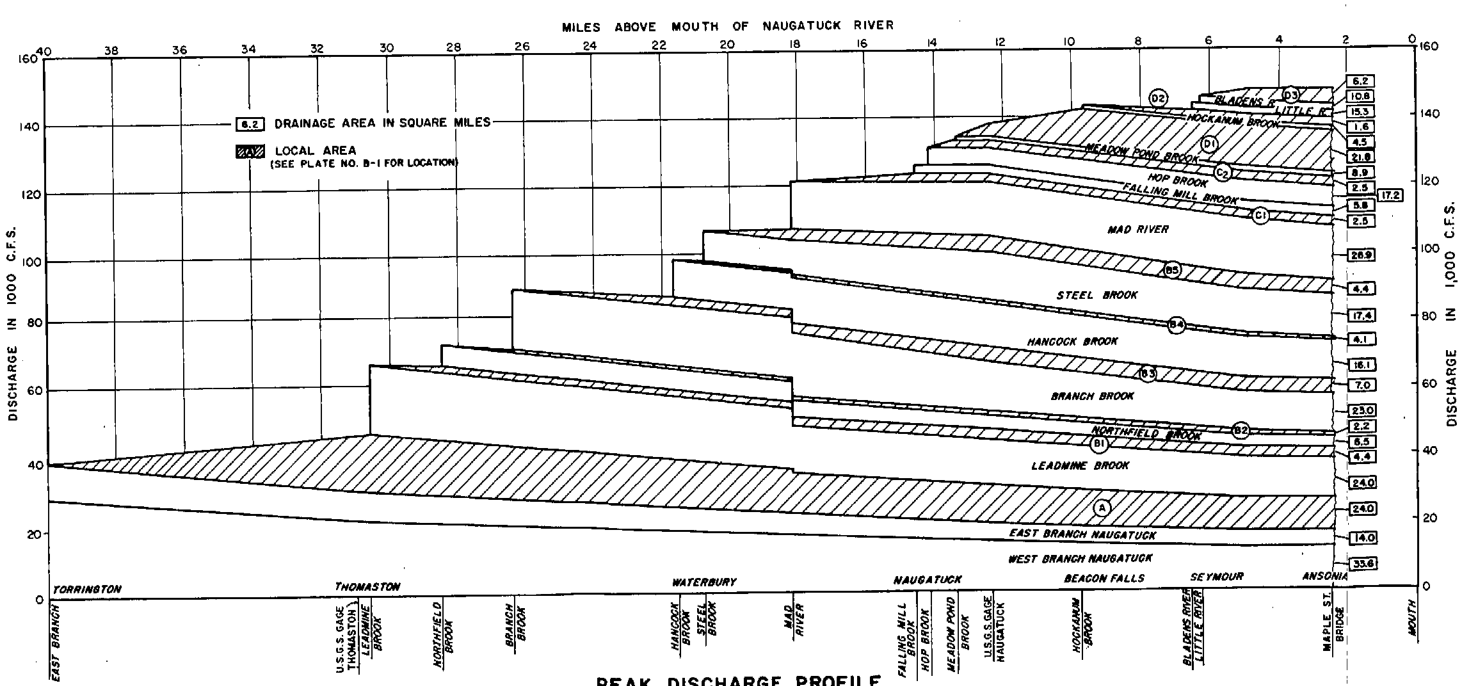








ISOHYETAL MAP
STANDARD PROJECT STORM
NAUGATUCK RIVER BASIN
96 HOUR DURATION



PEAK DISCHARGE PROFILE AND TRIBUTARY CONTRIBUTIONS

———— NATURAL

— — — MODIFIED BY THOMASTON RESERVOIR (ALSO APPLICABLE FOR THOMASTON, HALL MEADOW BROOK AND EAST BRANCH RESERVOIR)

—·—·— MODIFIED BY COMPREHENSIVE SYSTEM OF RESERVOIRS. THOMASTON RESERVOIR (PLUS HALL MEADOW BROOK AND EAST BRANCH RESERVOIRS) NORTHFIELD BROOK RESERVOIR BLACK ROCK RESERVOIR HOP BROOK RESERVOIR

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY R.W.M. TR. BY F.L.C. CK. BY

HOUSATONIC RIVER FLOOD CONTROL

E. F. Childs
CHIEF, HYD. & HYD. SECTION

STANDARD PROJECT FLOOD

SUBMITTED BY
CHIEF, PLANG & ENG'G BRANCH

NAUGATUCK RIVER WATERSHED CONN.

APPROVED:
CHIEF ENGINEERING DIV.

APPROVED Raymond A. Seifert
LT. COL. C.E. EXECUTIVE OFFICER

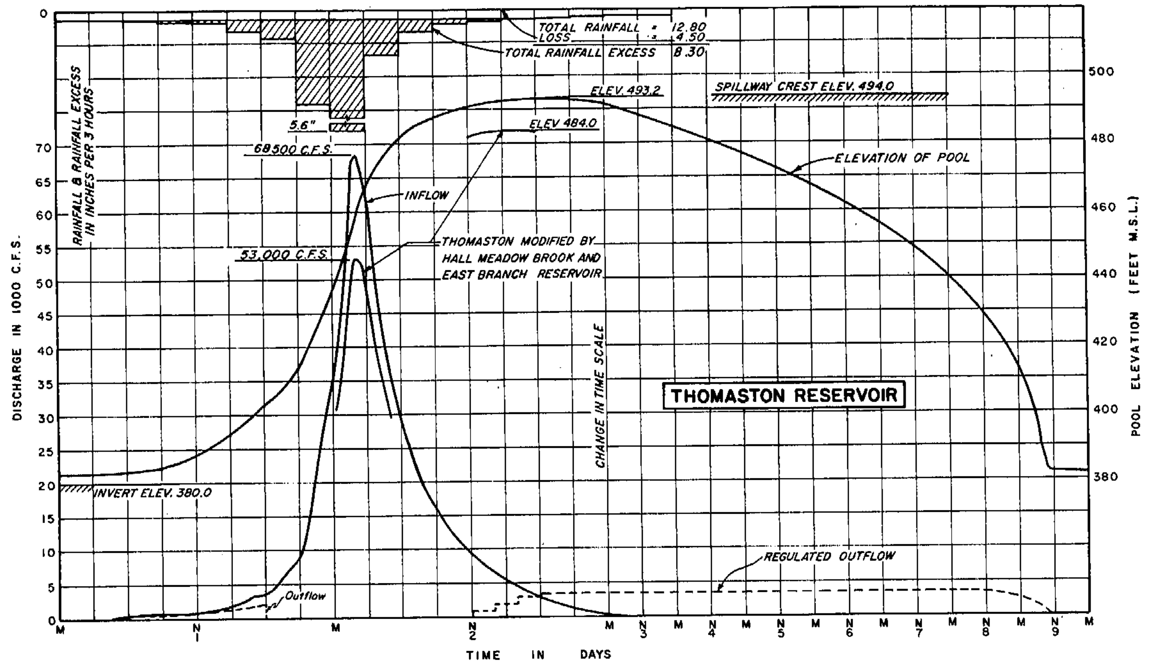
DATE JUNE 1958

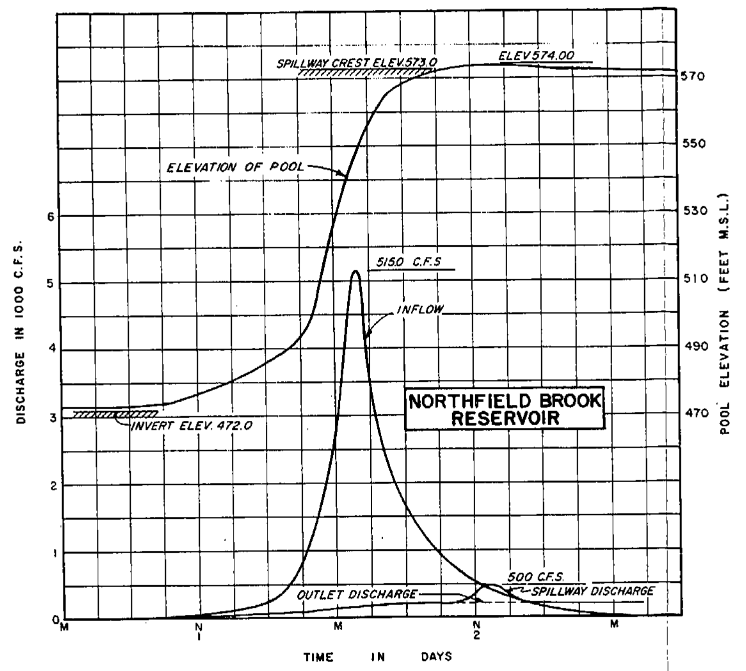
TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

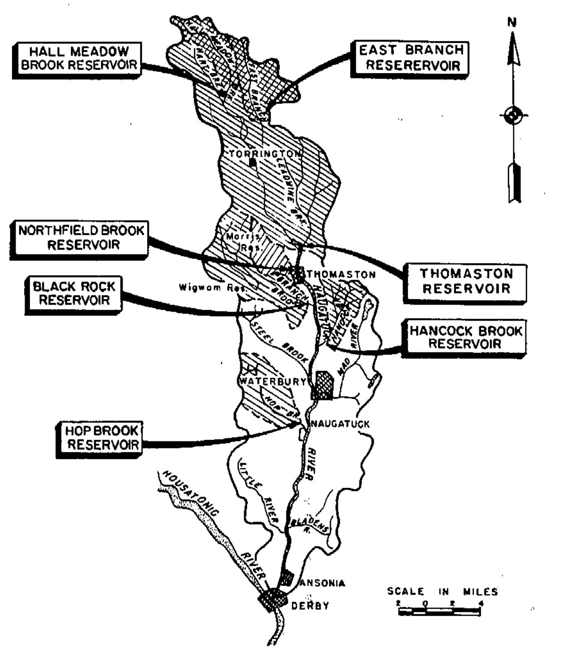
SCALE: AS NOTED
DRAWING NUMBER HC-1-1328
SHEET 1 OF 1

PLATE NO. B-9

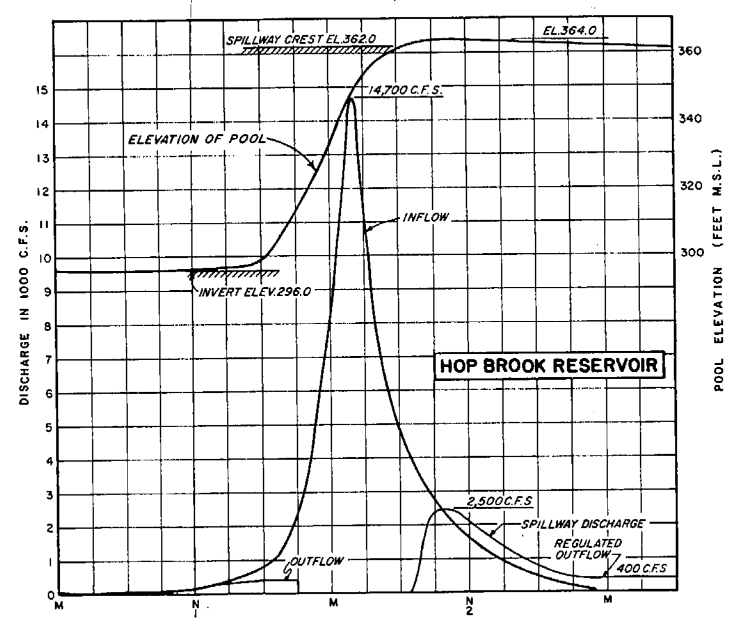
CORPS OF ENGINEERS U. S. ARMY

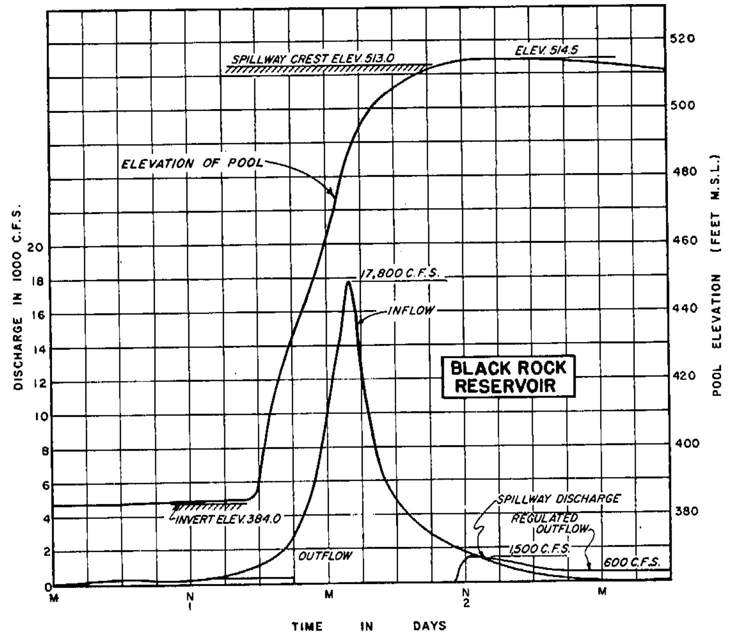


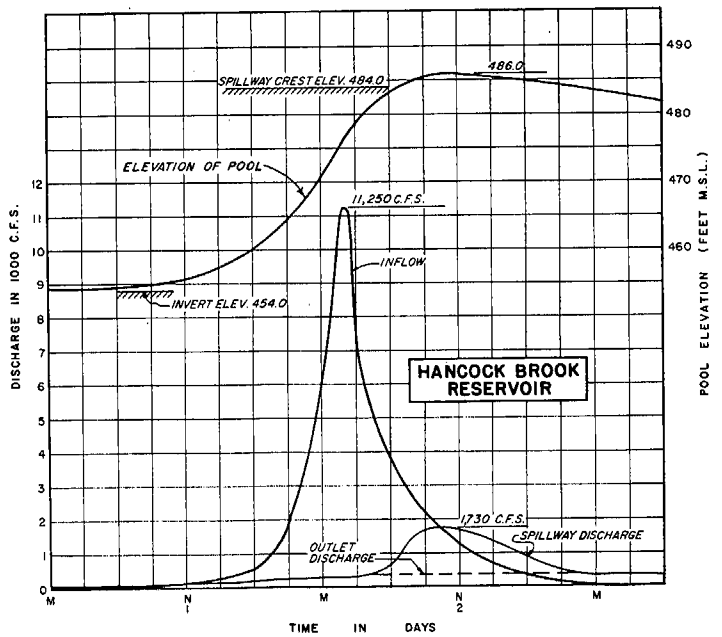




DRAINAGE AREA CONTROLLED BY COMPREHENSIVE SYSTEM OF RESERVOIRS







REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY R.W.M. | TR. BY M.W.B. | CK. BY

HOUSATONIC RIVER FLOOD CONTROL
RESERVOIR REGULATION
STANDARD PROJECT FLOOD
NAUGATUCK RIVER WATERSHED, CONN.

CHIEF, HYD. & HYD. SECTION
SUBMITTED BY
CHIEF, PLANN. & RPTS. BRANCH
APPROVED
CHIEF, ENGINEERING DIV.
APPROVED
LT. COL., C.E. EXECUTIVE OFFICER
DATE JUNE 1958

SCALE: AS SHOWN

TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

DRAWING NUMBER
HC-I-1329
SHEET 1 OF 1

PLATE NO. B-10

APPENDIX C

FLOOD LOSSES AND BENEFITS

APPENDIX C

FLOOD LOSSES AND BENEFITS

TABLE OF CONTENTS

TABLES

APPENDIX C

FLOOD LOSSES AND BENEFITS

1. DAMAGE SURVEYS

Preliminary damage surveys were made in the principal flood areas of the lower Naugatuck River Basin immediately after the flood of August 1955. In view of unprecedented flood stages and damages, losses were referenced to 1955 stages. Additional surveys were conducted during 1956 to obtain damage information for flood-control reservoir studies on the principal tributary streams.

Damage surveys consisted essentially of door-to-door interviews and inspections of hundreds of residential, commercial, industrial, and other properties affected by flooding. Recorded information included extent of the areas flooded, descriptions of property, nature and amount of damages, depths of flooding, high-water references, and relationships to prior flood stages. Damage estimates were generally furnished by property owners, although some estimates were modified by the investigators if owner evaluations appeared unreasonable. Sampling methods were used by the investigators to estimate losses of small groups of similar residences which experienced the same depth of flooding. Central sources of information and other valuable information from local, State, and utility officials were used extensively to save time and reduce survey costs.

Sufficient data were obtained to derive losses for (1) the 1955 flood crest, (2) a stage 3 feet above 1955 crest, (3) the stage at which damage begins referenced to the 1955 flood crest, and (4) intermediate stages indicating sharp changes in stage-loss relationships.

2. LOSS CLASSIFICATION

Flood loss information was recorded by type of loss and by location. Loss types used were urban (residential, commercial, public), industrial, highway, railroad, and utility. Losses were recorded by main-stem reaches of the Naugatuck River downstream of the Thomaston Dam site to provide a basis for analyses of average annual losses and benefits.

Losses evaluated in the surveys were the result of tangible, primary damages. Primary losses comprise physical losses such as damage to structures, equipment, stock, and costs of repair and clean-up; and non-physical losses such as unrecoverable loss of business, wages, or production, increased cost of operation, cost of temporary facilities, and increased cost of shipment in the flood areas.

Primary losses resulting from physical damage and a large part of the related non-physical loss were determined by direct inspection of property and evaluation of losses by property owners and field investigators. Where non-physical portions of primary losses could not be determined on the basis of available data, estimates were based upon the relationship between physical and non-physical losses for similar properties in the area.

No evaluations were made of secondary or intangible damages. Secondary damages, those incurred outside the immediate flood areas under study, include such items as business loss, loss of utilities and transportation facilities, and increased cost of travel and shipment of goods.

3. RECURRING AND PREVENTABLE LOSSES

Stage-loss and stage-discharge relationships were developed to reflect the magnitude of recurring losses at varying stages of flooding above and below the reference flood. The recurring losses used in development of the stage-loss relationship reflect economic and physical changes in the area since 1955 as revealed by the damage surveys. Table C-1 shows 1955 recurring losses after reductions by Thomaston, Hall Meadow, and East Branch Reservoirs and the P.L. 685 project at Waterville-Waterbury, and the losses prevented by combined operation of the Northfield Brook, Black Rock, Hancock Brook, and Hop Brook reservoirs, together with a description of the main damage zones in the lower Naugatuck River Basin.

4. ANNUAL LOSSES

Estimated recurring losses in the main damage zones of the lower Naugatuck River Basin were converted to annual losses as a basis for determining the annual benefits to be used in economic evaluation of flood control projects. These annual loss estimates were derived by correlation of stage-loss, stage-discharge, discharge-frequency and stage-frequency relationships, and by correlation of discharge-damage and discharge-frequency relationships, to produce damage-frequency relationships in accordance with standard practices of the Corps of Engineers. Average annual losses on Northfield, Branch, Hancock, and Hop Brooks, were determined by conversion of recurring record flood losses to annual losses by an established percentage relationship. This percentage relationship was determined by averaging the percentage relationship of the annual losses, obtained by standard methods, with the record flood losses found for all damage zones in southern New England. Average annual losses remaining after Thomaston, Hall Meadow, and East Branch Reservoirs and the P.L. 685 project at Waterville-Waterbury, and after the recommended plan are shown in Table C-2. Examples of curves used for computation of annual losses and benefits are shown on Plate No. C-1.

5. ANNUAL BENEFITS

Average annual flood damage prevention benefits were derived for the main damage zones in the lower Naugatuck River Basin by determining the

TABLE C-1

RECURRING AND PREVENTABLE LOSSES - FLOOD OF AUGUST 1955 - DESCRIPTION OF MAIN DAMAGE REACHES

LOWER NAUGATUCK RIVER
(1958 price level)

Reach	Recurring Losses after Thomaston Reductions *	Losses Preventable by Northfield, Black Rock, Hancock, and Hop Brooks	Residual Recurring Losses	Description
1.	---	---	---	Thomaston Dam to Oris Manufacturing Company dam at Reynolds Bridge.
2.	$ 40,000	$ 35,000	$ 5,000	Oris Manufacturing Company dam to mouth of Spruce Brook at Waterbury town line.
3.	2,550,000	2,430,000	120,000	Mouth of Spruce Brook to American Brass Company dam.
4.	4,915,000	2,705,000	2,210,000	American Brass Company dam to Bank Street bridge.
5.	1,890,000	1,565,000	325,000	Bank Street bridge to Platt Brothers and Company dam at lower Waterbury.
6.	4,430,000	3,135,000	1,295,000	Platt Brothers and Company dam to Beacon Falls Rubber Shoe Company dam.
7.	325,000	260,000	65,000	Beacon Falls Rubber Shoe Company dam to Seymour Manufacturing Company dam.
8.	2,615,000	1,425,000	1,190,000	Seymour Manufacturing Company dam to headwater of American Brass Company dam at Seymour.
9.	8,155,000	4,645,000	3,510,000	American Brass Company dam to tidewater at Division Street bridge on Derby town line.
10.	3,640,000	1,665,000	1,975,000	Downstream of Division Street bridge and including tidewater zone on the Housatonic River downstream of Shelton Canal Company dam.
TOTAL	$28,560,000	$17,865,000	$10,695,000	

*Includes reductions by Hall Meadow and East Branch Reservoirs and by P.L. 685 project at Waterville-Waterbury.

difference between average annual loss after discharge reductions by Thomaston, Hall Meadow, and East Branch Reservoirs and the P.L. 685 project at Waterville-Waterbury and those remaining after construction of four reservoirs on Northfield, Branch, Hancock, and Hop Brooks. Because of the very high percent reductions of discharge on the tributaries, the reservoir projects obtain average annual benefits equal to the average annual losses. Table C-3 presents a summary of the average annual flood damage prevention benefits realized by the individual projects in the reservoir system, as well as the annual benefits for each project acting last in the system of reservoirs.

TABLE C-2

RESIDUAL AVERAGE ANNUAL LOSSES
(1958 price level)

Zone	Average Annual Losses after Thomaston Reservoir Reductions*	Residual Average Annual Losses after Recommended Plan
1	-	-
2	$ 1,000	$ -
3	81,000	21,000
4	174,000	48,000
5	38,000	9,000
6	153,000	50,000
7	25,000	11,000
8	81,000	35,000
9	211,000	105,000
10	244,000	180,000
Tributaries	90,000	-
Total	$1,098,000	$459,000

*Includes reductions by Hall Meadow and East Branch Reservoirs and the P.L. 685 project at Waterville-Waterbury

TABLE C-3

TOTAL FLOOD DAMAGE PREVENTION BENEFITS
(1958 Price Level)

BENEFITS TO PROJECTS IN SYSTEM*

Projects	No Priority to Projects	Project as Last in System
Northfield Brook	$120,000	$107,000
Branch Brook	225,000	183,000
Hancock Brook	153,000	118,000
Hop Brook	141,000	116,000
Total	$639,000	

*After reductions by Thomaston, Hall Meadow and East Branch Reservoirs and the P.L. 685 project at Waterville-Waterbury.

(R 11/1/58)

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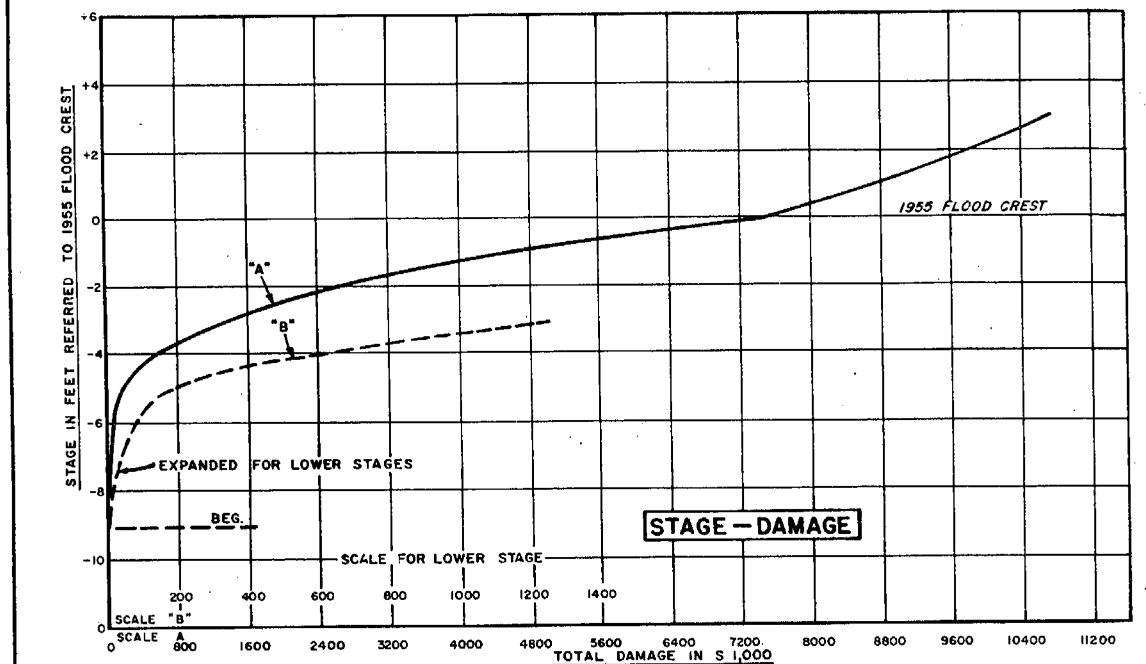
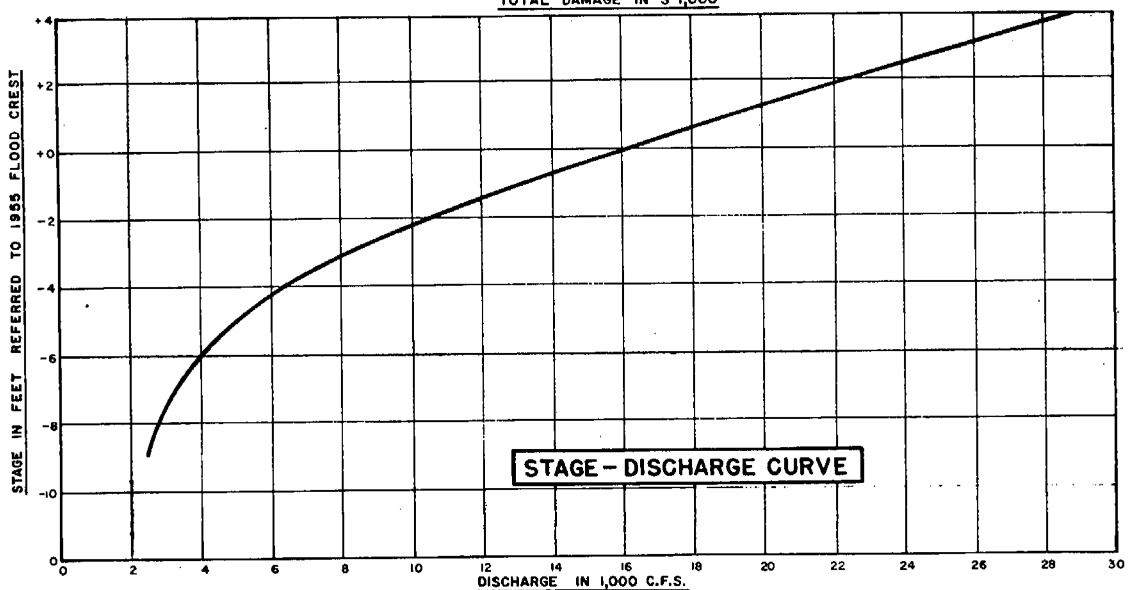
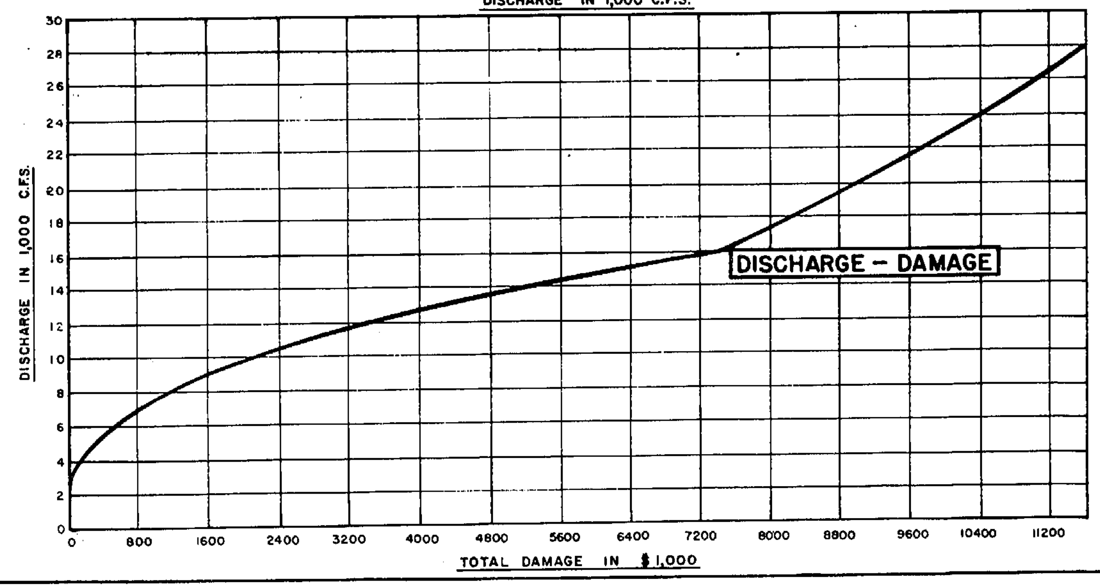
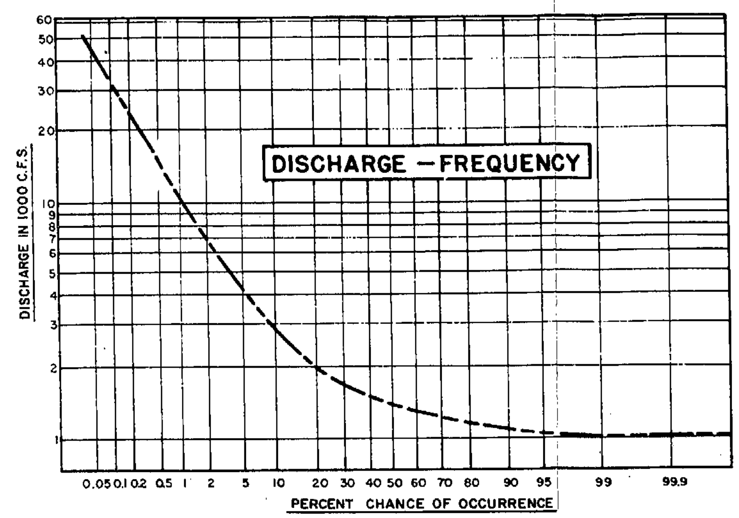
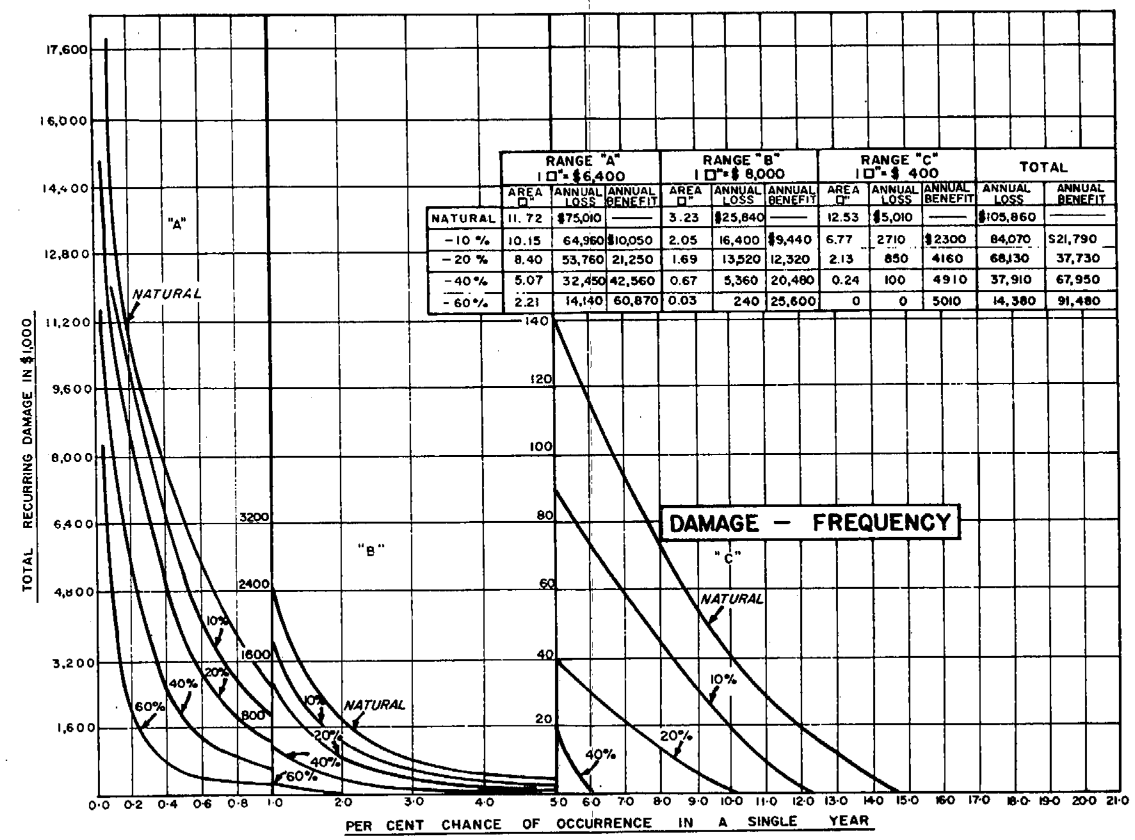


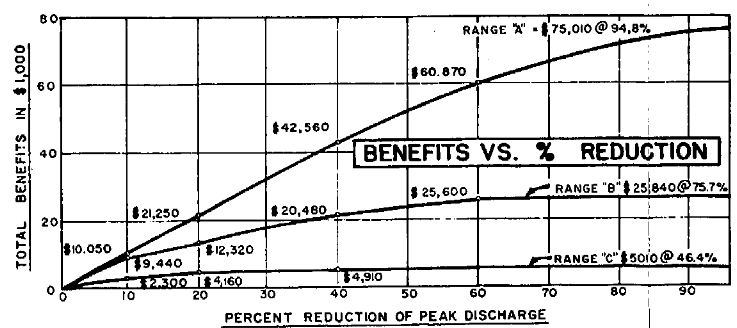








	RANGE "A" 1 □" = $6,400			RANGE "B" 1 □" = $ 8,000			RANGE "C" 1 □" = $ 400			TOTAL	
	AREA □"	ANNUAL LOSS	ANNUAL BENEFIT	AREA □"	ANNUAL LOSS	ANNUAL BENEFIT	AREA □"	ANNUAL LOSS	ANNUAL BENEFIT	ANNUAL LOSS	ANNUAL BENEFIT
NATURAL	11.72	$75,010	——	3.23	$25,840	——	12.53	$5,010	——	$105,860	——
−10 %	10.15	64,960	$10,050	2.05	16,400	$9,440	6.77	2710	$2300	84,070	$21,790
−20 %	8.40	53,760	21,250	1.69	13,520	12,320	2.13	850	4160	68,130	37,730
−40 %	5.07	32,450	42,560	0.67	5,360	20,480	0.24	100	4910	37,910	67,950
−60 %	2.21	14,140	60,870	0.03	240	25,600	0	0	5010	14,380	91,480



NOTE These curves depict the standard procedures in the New England Division.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS. U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS

DR. BY | TR. BY | CK. BY

TYPICAL CURVES FOR ECONOMIC ANALYSIS OF FLOOD CONTROL RESERVOIRS

G. R. Phippen
CHIEF ECONOMICS SECTION
SUBMITTED BY
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APPROVED Raymond A. Seifert
LT. COL. C.E. EXECUTIVE OFFICER

DATE JUNE 1958

SCALE

TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

DRAWING NUMBER CT-1-5543

SHEET 1 OF 1

PLATE NO. C-1

APPENDIX D

FLOOD CONTROL PLAN

APPENDIX D

FLOOD CONTROL PLAN

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APPENDIX D

FLOOD CONTROL PLAN

1. GENERAL

a. Regional geology and topography. The Housatonic River Basin is mainly in the Upland Section of the New England Physiographic Province. It is a maturely dissected upland with narrow, flat-topped hills, preserving in their relatively accordant summits the old, uplifted plain into which the present valleys have been incised. The valleys are generally well developed and well graded with few lakes or poorly drained, swampy reaches.

The bedrock of the region consists of Paleozoic and older, Archean rocks which have been folded and faulted. The early Paleozoic rocks, Cambrian and Ordovician shale and limestone, were metamorphosed to become the schist and marble which make the present ridges and valleys along the main axis of the Housatonic Valley. The Naugatuck and most of the other tributaries of the Housatonic flow through regions of hard rocks, schist, granite, and gneiss.

The overburden throughout the basin consists of till and outwash. A thin veneer of till composed of variable, silty, gravelly sand with cobbles and boulders covers the sides and crests of the hills in the basin except where rock is exposed on very steep slopes or along very narrow ridges. The valley bottoms are generally deeply filled with glacial till. Detritus, consisting of sand, silt, and gravel washed off the ice, was carried downstream and spread out across the valley floors, burying the till. Erosion since the disappearance of the glacier has left remnants of the outwash deposits which occur as scattered terraces on one or both walls of the present valleys.

b. Cost estimates.

(1) Basis of estimates. Topographic maps of the U. S. Army Map Service were supplemented by field surveys of the centerline profiles of the dams. Foundation conditions were determined by field reconnaissance and borings where necessary. Quantities of the principal construction items were estimated on the basis of a preliminary design which would provide safe structures for the given conditions and hydraulic criteria. A two-year construction period for all dams was assumed for purposes of determining Federal investment.

(2) Unit prices. Unit prices are based on average bid prices, adjusted to 1958 price level, for similar projects constructed or under construction in the New England Division. Minor items of work are included in the feature "Miscellaneous Items."

(3) Contingencies, engineering, and overhead. To cover contingencies, construction and relocation costs have been increased by 20%. Costs of engineering and design, and supervision and administration are estimated lump sums based on knowledge of the site and experience on similar projects. Costs of preauthorization studies are estimated on the basis of actual costs to date.

(4) Annual charges. The estimates for annual charges are based on 2.5% interest rate. The costs of the projects are amortized over an estimated 50-year useful economic life. Maintenance and operation costs are based on costs of similar projects in the New England Division and include an allowance for replacement of items estimated to have a life less than the life of the project. The estimated annual tax loss on lands transferred to Federal ownership is included as a non-Federal annual charge and excludes tax loss on improvements.

2. NORTHFIELD BROOK DAM AND RESERVOIR

a. Description.

(1) Reservoir. The Northfield Brook Dam site is located on Northfield Brook, 1 mile upstream from its confluence with the Naugatuck River in the town of Thomaston, Conn. The reservoir at spillway crest would extend about 1.2 miles up Northfield Brook and would have a surface area of approximately 60 acres. The reservoir would have a storage capacity of 2,430 acre-feet, all of which would be reserved for flood control, equivalent to 8.0 inches of runoff from the tributary drainage area of 5.7 square miles. The limits of the reservoir are shown on Plate No. 3 of the main report.

(2) Dam. The dam, with a top elevation of 588 feet, mean sea level datum, would be of rolled earth fill construction, approximately 800 feet long and a maximum height of 118 feet above the stream bed. A chute spillway, with an ogee weir 70 feet long at a crest elevation of 573, would be founded on rock in the right abutment of the dam. The spillway is designed for a 10-foot surcharge with 5 feet of freeboard between maximum water surface elevation and top of dam. The outlet works would consist of an ungated 36-inch reinforced concrete pipe, encased in concrete, and founded on rock on the right bank of the stream. A general plan and details of the dam are shown on Plate No. 4 of the main report.

b. Geology and soils.

(1) Geological investigations. Investigations at the site consisted of reconnaissance to determine general foundation conditions and to delineate the approximate location and extent of areas of bedrock outcrops. Rock outcrops and the approximate rock line along the centerline profile of the dam are shown on Plate No. 4 of the main report.

(2) Foundation conditions.

(a) Overburden. The overburden on both abutments consists of a thin blanket of till composed of silty, gravelly sand. In the valley bottom, superficial deposits of sand and gravel occur between bedrock outcrops.

(b) Bedrock. The bedrock is schist which is generally hard and sound with only nominal surface weathering. The trend of the bedrock structure is North 20° East magnetic, with the dip of the foliation westward.

(c) Leakage conditions in reservoir. Both abutments at the site are very wide, high bedrock ridges which are continuous and unbroken around the entire perimeter of the reservoir. The valley bottom at the site is also on bedrock. There is, therefore, no possibility of leakage from the reservoir.

(3) Construction materials.

(a) Pervious materials. Pervious materials occur in a large, commercially operated deposit west of Reynolds' Bridge, approximately 2 miles from the site.

(b) Impervious materials. Both of the high ridges which form the abutments of the dam are blanketed by deposits of till which are suitable for the impervious section of an earth fill dam. Although these till deposits are generally relatively thin in this area, thick deposits occur locally, and it is estimated that a suitable deposit could be located within 1 mile of the site.

(c) Rockfill and riprap. Rock from conduit and spillway excavations is suitable for use as rockfill and riprap. Additional rock required could be obtained from numerous areas of exposed bedrock in and adjacent to the reservoir.

(d) Concrete aggregates. In view of the small quantities of concrete required, only commercial sources of concrete aggregates have been considered. Aggregates are available from several commercial sources within a 10-mile haul distance of the site. Acceptance tests of some of these sources have been made in connection with other civil works projects in the vicinity.

(4) Conclusions and recommendations. Bedrock is available at the site at accessible depths to permit satisfactory cutoff of seepage throughout the entire length of the dam. Bedrock is also available to provide foundations for all concrete structures. Both the bedrock and the overburden are adequately strong to support design loads. All materials from excavations may be used in the

embankment. At this stage of the investigation, there are no apparent problems concerning structure foundations, seepage, or borrow materials for the dam.

c. Real estate.

(1) Character. The reservoir area contains woodland, pasture land, tillable land, and home sites. The reservoir also includes 2 farms, 1 of which is an idle dairy farm, and the other an idle poultry unit. There also is a lodge-type building which was developed by the Thomaston Rod and Gun Club and is presently owned by this Club. Field observation did not reveal any cemeteries or family burial plots. The highest and best use for the frontage along the one road which leads up through the valley would be for residential purposes with average size lots of 3 to 4 acres. Back from the highway the land rises very steeply and was formerly used for pasture land. Most of it has an inferior scattered tree growth upon it.

(2) Taking. The estimated costs are based on acquisition in fee title for dam site and reservoir areas. The guide taking line is established at 573 feet above mean sea level and will include an estimated 175 acres of reservoir, dam site, and road relocation areas.

(3) Mineral rights. A current field inspection revealed that no mineral mining operations are apparent in the required areas.

(4) Water rights. There is a small concrete dam which has been filled in with silt and gravel by recent floodwaters. Investigation discloses that it was built by the owner of the farm. A breached dry stone dam was also noted and indications are that this is nothing more than a farm pond. It was therefore concluded that there are no outstanding water rights in the area.

(5) Severance damage. Experience in this type of acquisition has proved that severance damage occurs. Ownerships and parts of ownerships are usually left without access. Since no maps showing property lines are available at this time, the damage is estimated at $14,500.

(6) Resettlement costs. Resettlement costs are based on recent experience for this type of property and are estimated as follows:

2 Farms	@	$ 750	$1,500
1 Club Building		1,000	1,000
Total Estimated Resettlement Costs			$2,500

(7) Acquisition costs. There are estimated to be 40 ownerships involved in this taking. Costs are based on a study of recent acquisition costs of this type.

Surveys and mapping		$ 80	
Appraisals		125	
Title evidence		125	
Negotiations, closings		250	
Costs per ownership		580	
40 Ownerships	@	580 each =	$23,200
Processing resettlement of residential and club claims - 3	@	75 each =	225
Subtotal			23,425
Division office overhead (3.6%)			843
Total estimated acquisition costs			24,268

(8) Valuation. The valuation of property is based on the Market Data Approach. The valuations reflected in this report are based on the study of recent sales.

(a) Improvements:

2	Farms	$44,500
1	Club Building	12,000
3	Improvements, total estimated cost	56,500

(b) Land:

6	Acres Developed homesites	@	$2,000	12,000
14	Acres Developable for Homesites	@	750	10,500
40	Acres Rear land	@	200	8,000
115	Acres Steep Hillside Land	@	50	5,750
175	Acres, total estimated cost			36,250

(9) Summary of real estate costs. A summary of the estimated costs of real estate for the Northfield Brook Dam and Reservoir project is given in Table D-1. Contingencies are estimated at 15 percent of the costs of lands and improvements, including severance.

TABLE D-1

SUMMARY OF REAL ESTATE COSTS

Improvements	$56,500
Land	36,250
Severance damages	14,500
Subtotal	107,250
Contingencies	15,982
Resettlement costs	2,500
Acquisition costs	24,268
Total estimated real estate cost	150,000

(10) Salvage value. For the purpose of determining the net Federal investment, the salvage value of the lands at the end of the economic life of the project (50 years) was estimated as shown in Table D-2. No salvage value was placed on land occupied by the dam and appurtenant structures.

TABLE D-2

SALVAGE VALUE OF LAND

Residential	6 acres @ $500		$ 3,000
Developable	14 acres @ 500		7,000
Rear land	40 acres @ 200		8,000
Steep hill land	115 acres @ 50		5,750
Gross value	175 acres		23,750
Less dam site area	9.5 acres @ 500		4,750
Total salvage value of land			19,000

d. Relocations.

(1) Cemeteries. There are no cemeteries lying within the reservoir area.

(2) Roads. The only road that will be affected by the construction of Northfield Brook Dam will be Litchfield Street in the town of Thomaston, Conn.; 1.7 miles of this road will require relocation. Cost of the relocation is based on replacement in kind of the existing facilities. Proposed road relocations are shown on Plate No. 3 of the main report.

(3) Utilities. There are 2 Connecticut Light and Power Company transmission lines that cross the reservoir. These lines will be raised to allow clearance during high water in the reservoir. Cost of this relocation is included in the estimate. The existing telephone and electric service lines along Litchfield Street will be relocated with the road relocation. Cost of these utility relocations is included in the cost of the road relocation.

e. Cost estimates. A breakdown of major construction items, together with their estimated costs, is given in Table D-3. The breakdown of costs of lands and damages is given in Paragraph 2c of this appendix and is summarized in Table D-1. Annual charges are given in Table D-4.

f. Benefits. Flood damage prevention benefits attributable to the Northfield Brook Reservoir in the recommended 4-reservoir system, after discharge reductions by Thomaston Reservoir, are $120,000. Incrementally, as the last reservoir in the system, benefits are $107,000. Derivation of benefits is discussed in Section XVIII of the main report and in Appendix C.

g. Benefit-cost ratio. The benefit-cost ratio for the Northfield Brook Reservoir in the recommended 4-reservoir system is 1.87 to 1; as the last reservoir in the system, the ratio is 1.66 to 1.

TABLE D-3

FIRST COST - NORTHFIELD BROOK DAM AND RESERVOIR
(1958 Price Level)

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Lands and damages			L.S.		$ 150,000
Relocations					
Roads	1.7	mile	L.S.	$194,000	
Utilities			L.S.	45,000	
Contingencies				48,000	
Total					287,000
Reservoir					
Clearing	10	acre	$350	3,500	
Contingencies				500	
Total					4,000
Dam					
Preparation of site	20	acre	600	12,000	
Stream control			L.S.	7,500	
Earth excavation (common)	8,000	c.y.	0.90	7,200	
Earth excavation (borrow)	524,000	c.y.	0.72	377,200	
Rock excavation (open cut)	8,800	c.y.	4.00	35,200	
Embankment (placing and rolling)	464,700	c.y.	0.25	116,200	
Rockfill (placing only)	10,500	c.y.	0.80	8,400	
Concrete, mass	1,000	c.y.	45.00	45,000	
Conduit complete				50,000	
Miscellaneous items				65,900	
Contingencies				145,400	
Total					870,000
Buildings, grounds, and utilities			L.S.		4,000
Total direct costs					1,315,000
Indirect costs					
Preauthorization studies				10,000	
Engineering and design (16%)				187,000	
Supervision and administration (8%)				108,000	
Total indirect costs					305,000
Total project first cost					1,620,000

TABLE D-4

ANNUAL CHARGES - NORTHFIELD BROOK DAM AND RESERVOIR
(1958 Price Level)

<u>Federal investment</u>		
Federal first cost	$1,620,000	
Interest during construction	40,000	
Gross Federal investment	1,660,000	
Salvage value of land	- 19,000	
Net Federal investment	1,641,000	
<u>Annual charges</u>		
<u>Federal</u>		
Interest ($1,660,000 x 2.5%)	41,500	
Amortization ($1,641,000 x 1.026%)	16,800	
Maintenance and operation	5,000	
Total Federal annual charges		$63,300
<u>Non-Federal</u>		
Loss of taxes on land		1,000
Total annual charges		64,300

3. BLACK ROCK DAM AND RESERVOIR

a. Description.

(1) Reservoir. The Black Rock Dam site is located on Branch Brook, 1.8 miles upstream from its confluence with the Naugatuck River in the town of Thomaston, Conn. The reservoir at spillway crest would extend about 1.3 miles up Branch Brook and have a surface area of approximately 180 acres. The reservoir would have a storage capacity of 8,860 acre-feet, all of which would be reserved for flood control, equivalent to 8.0 inches of runoff from the tributary drainage area of 20.8 square miles. The limits of the reservoir are shown on Plate No. 5 of the main report.

(2) Dam. The dam, with a top elevation of 533 feet, mean sea level datum, would be of rolled earth fill construction, approximately 1,100 feet long and a maximum height of 153 feet above stream bed. A side-channel spillway, with an ogee weir 170 feet long at elevation 513, would be founded on rock in the left abutment of the dam. The spillway is designed for a surcharge of 15 feet and 5 feet of freeboard between maximum water surface elevation and top of dam. A 54-inch reinforced concrete pipe encased in concrete will serve as a conduit. It would be constructed in rock along the left bank of the brook. Control of the flows through the conduit would be by means of 2-3'x4' hydraulically operated gates. A general plan and details of the dam are shown on Plate No. 6 of the main report.

b. Geology and soils.

(1) Surficial investigations. Reconnaissance of the site was made to investigate general foundation conditions and to determine the extent and location of required subsurface explorations. Because of the extensive bedrock exposures on both abutments and in the stream bed, explorations were not considered necessary for this preliminary stage of design. Rock outcrops and the approximate rock line along the centerline profile of the dam are shown on Plate No. 6 of the main report.

(2) Foundation conditions.

(a) Overburden. The overburden at the site consists of glacial till which thinly mantles the bedrock in scattered areas.

(b) Bedrock. The quartz mica schist at the site is light to dark grey, relatively hard and slightly weathered at the surface. It varies from massive to thin-bedded strata. The rock strikes in a northeasterly direction and dips upstream approximately 45°.

(c) Leakage conditions in the reservoir. The high valley walls which completely enclose the reservoir are wide bedrock ridges mantled with glacial till, so there is no possibility of leakage from the reservoir. Bedrock outcrops in the stream bed indicate that construction of an adequate cutoff to prevent seepage is possible at accessible depths.

(3) Construction materials.

(a) Pervious. The pervious materials for the dam can be obtained from pervious deposits immediately downstream of the site less than a half-mile haul distance.

(b) Impervious. Impervious material is available in the reservoir in the form of glacial till which is suitable as impervious fill.

(c) Rockfill and riprap. The rock excavated from the spillway and conduit excavation is suitable for use as rockfill and riprap.

(d) Concrete aggregates. Because of the small amount of concrete required in construction, only commercial sources have been considered. There are several established producers within a 10-mile haul of the site. Several of these producers have facilities for supplying transit-mixed concrete. Acceptance tests of materials from several producers in this area have been made previously for other civil works projects.

(4) Conclusions and recommendations. At the site, bedrock is available at accessible depths to permit adequate cutoff of seepage throughout the entire length of dam. The foundations, whether rock or overburden, are adequately strong to support design loads. Bedrock is available for foundations of all concrete structures. At this stage of investigations, there are no apparent problems concerning foundations or borrow materials. All materials from excavations may be used in the embankment.

c. Real estate.

(1) Character. The reservoir area includes home sites, pasture land, tillable land, woodland, and developable land. The reservoir also includes land owned by the Waterbury Water Commission and a portion of Black Rock State Park, owned and maintained by the State of Connecticut. The park lies in Thomaston and Watertown and contains 464 acres, including picnicking, bathing, and fishing facilities. There are no park improvements in the reservoir area. Three buildings, belonging to the Waterbury Water Commission, are in the reservoir area and will be relocated. Private ownerships include

dwellings, a farm, and a cider mill. Homes range from new, above average type construction to cheap, shack type dwellings.

(2) Taking. The estimated costs are based on acquisition in fee title for the dam site, reservoir area, and construction area. The guide taking line is established at 513 feet, mean sea level, and will include 240 acres for dam site, reservoir, and construction areas.

(3) Mineral rights. A recent field inspection revealed that no mineral mining operation is apparent in the proposed taking.

(4) Water rights. A preliminary survey of the proposed taking area failed to disclose any apparent water rights. Just above the taking area is a dam and reservoir owned and maintained by the Waterbury Water Commission.

(5) Severance. Experience in this type of acquisition has proved that severance damages occur when remaining ownerships are left without access. Since no maps showing property lines are available at this time, the damage is estimated at $10,000.

(6) Resettlement costs. Resettlement costs are based on recent experience for these types of properties and are estimated as follows:

1 Cider mill		$1,000	
1 Farm		1,000	
13 Residences	@ $600	7,800	
Total			$9,800
Processing resettlement of residential claims @ $75 each (13 x $75)			975
Processing resettlement of commercial claims @ $150 each (2 x $150)			300
Total estimated resettlement cost			11,075

(7) Acquisition costs. There are estimated to be 25 ownerships involved in this taking. Costs are based on a study of recent acquisition costs of this type in this area.

Survey and mapping	$ 100	
Title evidence	150	
Appraisals	150	
Negotiation, closing, etc.	150	
Subtotal	550	
Division office overhead (5.6%)	30	
Cost per ownership	580	
25 Ownerships @ $580 =	14,500	
Total estimated acquisition costs		$14,500

(8) Valuation. The valuation of property is based on the Market Data Approach. The valuations reflected in this report are based on the study of recent sales.

(a) Improvements

1	Cider mill	$3,000	
1	Farm	10,500	
13	Residences (incl. outbuildings)	120,700	
15	Improvements		
	Total estimated cost		$134,200

(b) Land

Residential 10 acres @	$4,000 =	$40,000	
Commercial 2 acres @	2,500	5,000	
Developable 30 acres @	2,000	60,000	
Park land 170 acres @	500	85,000	
Woodland 10 acres @	100	1,000	
Road area 15 acres		0	
River area 3 acres		0	
Total estimated cost			191,000

(9) Summary of real estate costs. A summary of the estimated costs of real estate for the Black Rock Dam and Reservoir project is given in Table D-5. Contingencies are estimated at 15 percent of the costs of lands and improvements, including severance.

TABLE D-5

SUMMARY OF REAL ESTATE COSTS

Land	$191,000
Improvements	134,200
Severance	10,000
Subtotal	335,200
Contingencies	67,300
Subtotal	402,500
Resettlement	11,000
Acquisition costs	14,500
Total estimated real estate cost	428,000

(10) Salvage value. For the purpose of determining the net Federal investment, the salvage value of lands at the end of the economic life of the project (50 years) was estimated as shown in Table D-6. No salvage value was placed on land occupied by the dam and appurtenant structures.

TABLE D-6

SALVAGE VALUE OF LAND

Residential	10 Acres	@	$500	$ 5,000
Commercial	2 "		500	1,000
Developable	30 "		500	15,000
Park land	170 "		500	85,000
Woodland	10 "		100	1,000
	222 Acres			107,000
Less dam site area:				
	20 Acres	@	500	10,000
	202 Acres			97,000

d. Relocations.

(1) Cemeteries. There are no cemeteries within the reservoir area.

(2) Roads. The only road that will be affected by the construction of Black Rock Dam will be Conn. State Route 109 in the town of Thomaston, Conn.; 2.2 miles of this road will require relocation. Cost of the relocation is based on replacement in kind of existing facilities. Proposed road relocations are shown on Plate No. 5 of the main report.

(3) Utilities.

(a) Electric service. There is a Connecticut Light and Power Company 27-kv. transmission line that passes over the proposed dam near the centerline. This line will be raised to give minimum clearance over the dam. Costs of this work are included in this estimate. The existing telephone and electric service along Route 109 will be relocated. Costs of these utility relocations are included in the cost of the road relocation.

(b) Water supply. The reservoir at spillway crest will back up to the toe of the Wigwam Dam of the Waterbury Water Co. This will necessitate the relocation of 2 chlorination buildings and a chemical building.

e. Cost estimates. A breakdown of major construction items together with their estimated costs is given in Table D-7. The breakdown of costs of the lands and damages is given in paragraph 3.c of this appendix and is summarized in Table D-5. Annual charges are given in Table D-8.

f. Benefits. Flood damage prevention benefits attributable to the Black Rock Reservoir in the recommended 4-reservoir system, after discharge reductions by Thomaston Reservoir, are $227,000. Incrementally, as the last reservoir in the system, benefits are $185,000. Derivation of benefits is discussed in Section XVIII of the main report and in Appendix C.

g. Benefit-cost ratio. The benefit-cost ratio for the Black Rock Reservoir in the recommended 4-reservoir system is 1.61 to 1; as the last reservoir in the system, the ratio is 1.31 to 1.

TABLE D-7

FIRST COST - BLACK ROCK DAM AND RESERVOIR
(1958 Price Level)

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Lands and damages			L.S.	$	$ 428,000
Relocations					
Roads	2.2	mile	L.S.	411,000	
Chlorination Plant			L.S.	50,000	
27 kv. powerline			L.S.	25,000	
Contingencies				97,000	
Total					583,000
Reservoir					
Clearing	28	acre	$350	9,800	
Contingencies				2,200	
Total					12,000
Dam					
Preparation of site	19	acre	600	11,400	
Stream control	1		L.S.	10,000	
Earth excavation (common)	13,571	c.y.	0.70	9,500	
Earth excavation (borrow)	907,167	c.y.	0.60	544,300	
Rock excavation (open cut)	40,200	c.y.	3.50	140,700	
Embankment (placing and rolling)	790,400	c.y.	0.25	197,600	
Rockfill (placing only)	49,250	c.y.	0.80	39,400	
Concrete, mass	7,800	c.y.	35.00	273,000	
Concrete, reinf.	1,330	c.y.	60.00	79,800	
Gates and machinery	1		L.S.	60,000	
Operating house superstructure	3,800	c.f.	2.50	9,500	
Service bridge	3,730	s.f.	20	74,600	
Miscellaneous items				144,200	
Contingencies				319,000	
Total					1,913,000

TABLE D-7, Cont.

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Dam, Cont.					
Access road	0.8	mile		$54,200	
Contingencies				10,800	
Total					65,000
Buildings, grounds, and utilities					
Minor appurtenances			L.S.	4,000	4,000
Total direct costs					3,005,000
Indirect costs					
Preauthorization studies				10,000	
Engineering and design (12%)				305,000	
Supervision and administration (8%)				230,000	
Total indirect costs					545,000
Total project first cost					3,550,000

TABLE D-8

ANNUAL CHARGES - BLACK ROCK DAM AND RESERVOIR
(1958 Price Level)

Federal investment		
Federal first cost	$3,550,000	
Interest during construction	89,000	
Gross Federal investment	3,639,000	
Salvage value of land	- 97,000	
Net Federal investment	3,542,000	
Annual charges		
Federal		
Interest ($3,639,000 x 2.5%)	91,100	
Amortization ($3,542,000 x 1.026%)	36,300	
Maintenance and operation	10,000	
Total Federal annual charges		$137,400
Non-Federal		
Loss of taxes on land		3,700
Total annual charges		141,100

4. HANCOCK BROOK DAM

a. Description.

(1) Reservoir. The Hancock Brook Dam site is located on Hancock Brook in the town of Plymouth, Conn., 3.4 miles upstream from its confluence with the Naugatuck River. The reservoir at spillway crest would extend about 1.4 miles up Hancock Brook and 1.2 miles up Todd Hollow Brook and have a surface area of approximately 300 acres. The reservoir would have a storage capacity of 3,820 acre-feet, all of which would be reserved for flood control, equivalent to 6.0 inches of runoff from the tributary drainage area of 12.0 square miles. The limits of the reservoir are shown on Plate No. 7 of the main report.

(2) Dam. The dam, with a top elevation of 499 feet, mean sea level datum, would be of rockfill construction approximately 615 feet long and a maximum height of 50 feet above the stream bed. A chute spillway with an ogee weir 145 feet long at crest elevation 484 feet would be founded on rock in the right abutment of the dam. The spillway is designed for a 10-foot surcharge with 5 feet of freeboard between maximum water surface elevation and top of dam. The outlet works would consist of an ungated 48" reinforced concrete pipe encased in concrete and founded on rock on the right bank of the stream. A general plan and details of the dam are shown on Plate No. 8 of the main report.

b. Geology and soils.

(1) Surficial and subsurface investigations. Geological reconnaissance of the site was made to determine general foundation conditions and to ascertain the necessity for and the location of subsurface explorations. Foundation explorations consisting of 4 test borings, located as shown on Plate D-1 of this appendix, were completed at the site. The borings were continuously drive-sampled in overburden, and the rock was diamond core-drilled. Overburden samples were classified according to the Unified Soils Classification System. The classification of all overburden samples and a description of rock cores recovered from the borings are also shown on Plate No. D-1 of this appendix.

(2) Foundation conditions.

(a) Overburden. Overburden on the right abutment consists of a thin veneer of glacial till overlying the bedrock. The average depth of overburden is generally less than 10 feet. On the left abutment, a rock drumlin, the overburden is glacial till overlying the rock surface with an average depth generally less than 25 feet at the lower elevations and decreasing in thickness as the abutment rises. Numerous boulders mantle the till surfaces with several large areas of boulder concentrations on the right abutment. The valley section is located in the remnant of a post-glacial lake and the overburden consists of variably stratified, pervious silty sands and gravels with the average depth of overburden generally less than 30 feet. In the small saddle located east of the left abutment, the overburden is generally less than 10 feet in depth. It consists of variably stratified pervious sands and gravels overlying a badly weathered rock surface. As the elevation of this saddle is higher than the proposed top of dam, it presents no problem in the present design.

(b) Bedrock. The bedrock at the site is a granitized mica schist, generally hard and fresh, light to dark gray, with numerous granitized zones and quartz stringers. The apparent dip of foliation is 30°. At the saddle, the rock is a mica schist, but the rock cores show evidence of faulting in FD2 and FD4. In FD2, slickensided surfaces occur at 33.5' and in FD4, abrecciated zones extend from 18.2' to 30.0'. This zone has been poorly recemented with a soft graphitic matrix.

(c) Groundwater. Levels of subsurface water, as indicated by observations in borings during drilling operations, are essentially at river level in the valley section. On both abutments, it is expected that the ground water level is located close to the bedrock surface and ground water will probably be encountered at relatively shallow depths in any proposed excavations.

(d) Leakage conditions in the reservoir. The high valley walls which completely enclose the reservoir are wide bedrock ridges mantled with glacial till, so there is no possibility of leakage from the reservoir. Exploration in the narrow valley section indicates a moderate thickness of pervious materials to the rock surface, and construction of an adequate cutoff to prevent seepage is possible at accessible depths.

(3) Construction materials.

(a) Pervious. The pervious materials for the dam can be obtained from pervious glacial lake deposits in the reservoir within approximately one-half mile of the dam site.

(b) Impervious. Impervious material in the form of glacial till suitable for use as impervious fill is available in the reservoir area within a mile haul of the dam site.

(c) Rockfill and riprap. The rock excavated from the spillway and proposed railroad relocation will be suitable for rockfill and riprap. The amount available is adequate to meet all requirements for dam construction.

(d) Concrete aggregates. Because of the relatively small amount of concrete required in construction, only commercial sources have been considered. There are several established producers within a 5-mile haul of the site. Several of these producers have facilities for supplying transit-mixed concrete. Acceptance tests of materials from several producers in this area have been made previously for other civil works projects.

(4) Conclusions and recommendations. At the dam site, relatively impervious till or bedrock is available at accessible depths to permit adequate cutoff of seepage throughout the entire length of dam. The foundations, whether overburden or bedrock, are adequately strong to support design loads. Bedrock is available for foundations for all concrete structures. At this stage of investigations, there are no apparent problems concerning structure foundations, seepage or borrow for embankment construction.

c. Real estate.

(1) Character. Land in the reservoir area includes homesites, overgrown pasture land, a small amount of tillage, developable land, woodland, and swamp. The taking area also includes 2 commercial gravel operations whose potential is almost exhausted. There is evidence of gravel banks along the westerly side of Todd Hollow Brook. Homes in this area are in a moderate price range of $10,000 to $15,000. The general area seems to be static with the exception of Waterbury Road where a few houses are being constructed.

(2) Taking. The estimated costs are based on acquisition in fee for the dam site, reservoir, and construction areas.

(3) Mineral rights. A recent field inspection revealed that no mineral mining operation is apparent in the required areas except for sand and gravel operations.

(4) Water rights. There are no apparent water rights in the reservoir area.

(5) Gravel pit. Within the reservoir area, there are 2 commercially operated gravel pits whose potentials appear almost exhausted.

(6) Severance. Experience in this type of acquisition has proved that severance damage occurs. Ownerships and parts of ownerships are usually left without access. Since no maps showing property lines are available at this time, the damage is estimated at $15,000.

(7) Resettlement costs. Resettlement costs are based on recent experience for this type of property and are estimated as follows:

2	Gravel Pits	@	$1,000	=	$2,000
21	Residences	@	600		12,600

Total estimated resettlement costs $14,600

(8) Acquisition costs. There are estimated to be 40 ownerships involved in this taking. Costs are based on a study of recent acquisition costs of this type.

Surveys and mapping	$ 80	
Appraisals	125	
Title evidence	125	
Negotiations, closings	250	
Costs per ownership	580	
40 ownerships @ $580 each		$23,200
Processing resettlement of residential claims 21 @ $75 each		1,575
Processing resettlement of commercial claims 2 @ 150 each		300
Total estimated acquisition costs		25,075

(9) Valuation. The valuation of property is based on the Market Data Approach. The valuations reflected in this report are based on the study of recent sales.

(a) Improvements.

1	Gravel washer	$3,000
1	Office building	5,000
1	Loading platform	2,000
21	Residences, including outbuildings	248,700
24	Improvements -	
	Total estimated cost	258,700

(b) Land

Residential, improved		
10 acres @ $2,000		$20,000
Residential, unimproved		
70 acres @ $500		35,000
Developable		
40 acres @ 200		8,000
Active gravel pit		
15 acres -		9,000
Swamp land		
100 acres @ 10		1,000
Woodland		
165 acres @ 50		8,250
400 acres		
Total estimated cost		81,250

(10) Summary of real estate costs. A summary of the estimated costs of real estate for the Hancock Brook Dam and Reservoir project is given in Table D-9. Contingencies are estimated at 15 percent of the costs of lands and improvements, including severance.

TABLE D-9

SUMMARY OF REAL ESTATE COSTS

Land	$81,250
Improvements	258,700
Severance damages	15,000
Subtotal	354,950
Contingencies	53,375
Subtotal	408,325
Resettlement cost	14,600
Acquisition cost	25,075
Total estimated real estate cost	448,000

(11) Salvage value. For the purpose of determining the net Federal investment, the salvage value of lands, at the end of the economic life of a project (50 years), was estimated as shown in Table D-10. No salvage value was placed on land occupied by the dam and appurtenant structures.

TABLE D-10

SALVAGE VALUE OF LAND

Residential, improved		
10 acres @ $500	=	$ 5,000
Residential, unimproved		
70 acres @ $500		35,000
Developable		
40 acres @ $200		8,000
Active gravel pit		
15 acres		9,000
Swamp Land		
100 acres @ $10		1,000
Woodland		
165 acres @ $50		8,250
400 acres		66,250
Less dam site area:		
5 acres @ $50		250
395 acres		66,000

d. Relocations.

(1) Cemeteries. There are no cemeteries within the reservoir area.

(2) Roads. The only road that will be affected by the construction of Hancock Brook Dam will be Waterbury Road, in the town of Plymouth, Conn.; 0.7 miles of this road will require relocation. Cost of the relocation is based on replacement in kind of the existing facilities. Proposed road relocations are shown on Plate No. 7 of the main report.

(3) Railroads. The Waterbury to Hartford line of the New York, New Haven and Hartford Railroad will be relocated around the reservoir for a distance of 1.8 miles. The railroad will rise at the maximum allowable grade of 1.1% for a distance of 1.4 miles through a maximum cut of 50 feet. The proposed relocation is shown on Plate No. 7 of the main report.

e. Cost estimates. A breakdown of major construction items together with their estimated costs is given in Table D-11. The breakdown of cost of lands and damages is given in paragraph 4c. of this appendix and is summarized in Table D-9. Annual charges are given in Table D-12.

f. Benefits. Flood damage prevention benefits attributable to the Hancock Brook Reservoir in the recommended 4-reservoir system, after discharge reductions by Thomaston Reservoir, are $153,000. Incrementally, as the last reservoir in the system, benefits are $118,000. Derivation of benefits is discussed in Section XVIII of the main report and in Appendix C.

g. Benefit-cost ratio. The benefit-cost ratio for the Hancock Brook Reservoir in the recommended 4-reservoir system is 1.56 to 1; as the last reservoir in the system, the ratio is 1.20 to 1.

TABLE D-11

FIRST COST - HANCOCK BROOK DAM AND RESERVOIR
(1958 Price Level)

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Lands and damages			L.S.	$	$448,000
Relocations					
Roads	1.3	mile	L.S.	272,000	
Railroads			L.S.	623,700	
Contingencies				179,300	
Total					1,075,000
Reservoir					
Clearing	90	acre	$350	31,500	
Contingencies				6,500	
Total					38,000
Dam					
Preparation of site	4	acre	600	2,400	
Stream control			L.S.	3,500	
Earth excavation (common)	16,857	c.y.	0.70	11,800	
Earth excavation (borrow)	35,143	c.y.	0.70	24,600	
Rock excavation (open cut)	63,900	c.y.	3.00	191,700	
Embankment (placing & rolling)	30,571	c.y.	0.35	10,700	
Rockfill (placing only)	60,833	c.y.	0.60	36,500	

TABLE D-11 (Cont.)

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Dam, Cont.					
Concrete, mass	1,100	c.y.	$40	$44,000	
Conduit complete			L.S.	47,000	
Miscellaneous items				37,000	
Contingencies				79,800	
Total					$489,000
Roads					
Access road	0.6	mile	L.S.	63,000	
Contingencies				13,000	
Total					76,000
Buildings, grounds, and utilities			L.S.		4,000
Total direct costs					2,130,000
Indirect costs					
Preauthorization studies				20,000	
Engineering and design (13%)				220,000	
Supervision and administration (8%)				150,000	
Total indirect costs					390,000
Total project first cost					2,520,000

TABLE D-12

ANNUAL CHARGES - HANCOCK BROOK DAM AND RESERVOIR
(1958 Price Level)

Federal investment		
Federal first costs	$2,520,000	
Interest during construction	63,000	
Gross Federal investment	2,583,000	
Salvage value of land	-66,000	
Net Federal investment	2,517,000	
Annual charges		
Federal		
Interest ($2,583,000 x 2.5%)	64,600	
Amortization ($2,517,000 x 1.026%)	25,800	
Maintenance and operation	5,000	
Total Federal annual charges		$95,400
Non-Federal		
Loss of taxes on land		2,800
Total annual charges		98,200

5. HOP BROOK DAM AND RESERVOIR

a. Description.

(1) Reservoir. The Hop Brook Dam site is located on Hop Brook in the town of Middlebury, Conn., approximately 1.2 miles upstream of the confluence of the Naugatuck River and Hop Brook. The reservoir at spillway crest would extend about 1.6 miles up Hop Brook and have a surface area of approximately 280 acres. The reservoir would have a capacity of 6,840 acre-feet of storage, all reserved for flood control, equivalent to 8.0 inches of runoff from the net drainage area of 16.0 square miles. The limits of the reservoir are shown on Plate No. 9 of the main report.

(2) Dam. The dam, with top elevation of 377 feet, mean sea level datum, would be of earth fill construction, approximately 470 feet long with a maximum height of 82 feet above the stream bed. An L-shaped side-channel spillway at crest elevation 362 feet, mean sea level datum, 230 feet long, would be constructed in rock in the left abutment. The spillway is designed for a 10-foot surcharge and 5 feet of freeboard between maximum water surface elevation and top of dam. A 48-inch reinforced concrete pipe encased in concrete, to serve as the conduit, would be constructed along the right bank of the brook. Control of flows through the conduit would be by means of 2-3'x3' hydraulically operated gates. A general plan and details of the dam are shown on Plate No. 10 of the main report.

b. Geology and soils.

(1) Surficial and subsurface investigations. Geological reconnaissance of the site was made to determine general foundation conditions and to ascertain the necessity for and the location of subsurface explorations. Foundation explorations consisted of 5 test borings, located as shown on Plate No. D-2 of this appendix. The borings were continuously drive-sampled in overburden and the rock was diamond core-drilled. Overburden samples from the borings were classified according to the Unified Soils Classification System. The description of all overburden samples and a description of rock cores recovered from the borings are shown on Plate No. D-3 of this appendix.

(2) Foundation conditions.

(a) Overburden. The overburden throughout the site area is generally 15 feet or less in thickness and consists of variable, relatively impervious silty sands and gravels, with numerous cobbles and boulders at the surface and throughout the overburden.

(b) Bedrock. The bedrock at the site is a granitic gneiss with foliation poorly developed. The rock is dark gray, fine to coarse-grained and relatively hard and fresh with numerous granitized zones and quartz stringers throughout. Slight weathering has occurred along numerous open joints and broken zones. Slickensided surfaces were noted in FD-2 along a 45° joint at a depth of 25 feet.

(c) Ground water. Levels of subsurface water observed in borings during drilling operations appear to be erratic and inconclusive. It is expected, however, that the ground water surface is at or close to the bedrock surface generally throughout the site area, except in the valley section where subsurface water is at stream level.

(d) Leakage conditions in the reservoir. The high valley walls which completely enclose the reservoir are wide bedrock ridges mantled with glacial till, so there is no possibility of leakage from the reservoir. Exploration and reconnaissance in the valley section indicates rock at shallow to moderate depths, and construction of an adequate cutoff to prevent seepage is possible.

(3) Construction materials.

(a) Pervious. The pervious material for the dam can be obtained from pervious terrace deposits in the proposed reservoir area, less than a mile haul distance from the site.

(b) Impervious. Impervious material is available in the reservoir area in the form of glacial till.

(c) Rockfill and riprap. The rock excavated from the spillway and the numerous boulders at the site are suitable for rockfill or riprap. Additional rock, if needed, can be obtained from established commercial quarries within a 5-mile haul distance.

(d) Concrete aggregates. Because of the small amount of concrete required in construction, only commercial aggregate sources have been considered. There are several established producers within a 4-mile haul of the site. Several of these producers have facilities for supplying transit-mixed concrete. Acceptance tests of materials from several producers in this area have been made previously for other civil works projects.

(4) Conclusions and recommendations. At the site, bedrock is available at accessible depths to permit adequate cutoff of seepage throughout the entire length of the dam and dike. The foundations, whether overburden or bedrock, are adequately strong to support design loads. Bedrock foundation is available for all concrete structures. At this preliminary stage of investigations, there are

no apparent problems concerning structure foundations, seepage, or borrow for embankment construction.

c. Real estate.

(1) Character. The roadside areas have been subject to scattered developments. The interior areas consist of partly cleared land. The wooded land of mixed growth is insufficient in quantity and type to profitably conduct a lumbering operation.

(2) Taking. The estimated costs are based on acquisition in fee title for the dam site and reservoir areas. The guide taking line is established at 367 feet above mean sea level, which is 5 feet above spillway crest elevation of 362 feet, and will include an estimated 394 acres of reservoir, dam site, borrow, relocation, and work areas.

(3) Mineral rights. No mining operations were noted in the proposed taking area.

(4) Water rights. No water rights were noted. A further study is necessary to determine any rights that may exist below the proposed dam site.

(5) Severance damage. This type acquisition by necessity creates a severance damage because in some cases the remaining property will have little or no value. Due to the lack of sufficient maps indicating property lines, an estimated item of $20,000 is included for expected severance damage.

(6) Resettlement costs. Resettlement costs are based on recent experience for this type of property and are estimated as follows:

Resettlement of families				
43	@	$ 600	=	$25,800
Resettlement of businesses				
3	@	1,000		3,000
Processing claims of families				
43	@	75		3,225
Processing claims of businesses				
3	@	150		450
Total estimated resettlement				32,475 - say $33,000

(7) Acquisition costs. Acquisition costs are based upon a study of recent costs for this type acquisition.

Survey and mapping	$ 80
Appraisals	125
Title evidence	125
Negotiations, closing, condemnation	250
Cost per ownership	580

80 tracts in the taking area @ $580 = $46,400 say $46,000

(8) Valuation. The valuation of property is based on the Market Data Approach, a study of recent sales in the area, and information received from reliable city and town officers.

(a) Improvements

41	Residences and outbuildings	$659,000	
3	Commercial properties	49,000	
44	Improvements		
	Total estimated cost		$708,000

(b) Land

Developed house lots 35 acres	@	$2,000 -	70,000
Potential house lots 20 acres	@	1,500	30,000
Brooks and ponds 15 acres	@	300	4,500
Existing roads 20 acres		Nominal	-
Relocated roads 29 acres	@	500	14,500
Swamp 5 acres	@	100	500
Tillage 85 acres	@	1,000	85,000
Wooded 155 acres	@	500	77,500
Commercial lots 5 acres	@	3,000	15,000
Pasture 25 acres	@	700	17,500
394 acres Total land value			314,500 - say 315,000

(c)	Severance	$ 20,000
(d)	Contingencies	100,000
(e)	Resettlement costs	33,000
(f)	Acquisition costs	46,000
	Total estimated real estate cost	$1,222,000

(9) Summary of real estate costs. A summary of the estimated cost of real estate for the Hop Brook Dam and Reservoir project is given in Table D-13. Contingencies are estimated at approximately 10 percent of the cost of lands and improvements, including severance.

TABLE D-13

SUMMARY OF REAL ESTATE COSTS

Land	$ 315,000	
Improvements	708,000	
Severance damages	20,000	
Subtotal	1,043,000	
Contingencies	100,000	
Subtotal	1,143,000	
Resettlement costs	33,000	
Acquisition costs	46,000	
Total estimated real estate cost		$1,222,000

(10) Salvage value. For purposes of determining the net Federal investment, the salvage value of lands at the end of the economic life of the project (50 years) was estimated as shown in Table D-14. No salvage value was placed on land occupied by the dam and appurtenant structures.

TABLE D-14

SALVAGE VALUE OF LAND

Residential			
20 acres	@ $500	-	$ 10,000
Industrial and Commercial			
5 acres	@ 500		2,500
Developable			
35 acres	@ 500		17,500
Agriculture			
85 acres	@ 500		42,500
Pasture			
25 acres	@ 500		12,500
Relocated roads			
29 acres	@ 500		14,500
Woodland			
145 acres	@ 500		72,500
Swamp			
5 acres	@ 100		500
Brooks and ponds			
15 acres	@ 300		4,500
364 acres			
Total			177,000

d. Relocations.

(1) Cemeteries. There are no cemeteries within the reservoir area.

(2) Roads. The only road that will be affected by the construction of Hop Brook Dam will be Conn. State Route 63 in the town of Middlebury, Conn.; 2.12 miles of this road will require relocation. Cost of the relocation is based on replacement in kind of existing facilities. The proposed road relocation is shown on Plate No. 9 of the main report.

(3) Utilities. The only utilities known to require relocation consist of electric service and telephone lines along the existing road which is to be relocated. Costs of utility relocations are included in the cost of road relocation.

e. Cost estimate. A breakdown of major construction items together with their estimated costs is given in Table D-15. The breakdown of costs of lands by damages is given in paragraph 5.c. of this appendix and is summarized in Table D-13. Annual charges are given in Table D-16.

f. Benefits. Flood damage prevention benefits attributable to the Hop Brook Reservoir in the recommended 4-reservoir system, after discharge reductions by Thomaston Reservoir, are $141,000. Incrementally, as the last reservoir in the system, benefits are $116,000. Derivation of benefits is discussed in Section XVIII of the main report and in Appendix C.

g. Benefit-cost Ratio. The benefit-cost ratio for the Hop Brook Reservoir in the recommended 4-reservoir system is 1.25 to 1; as the last reservoir in the system, the ratio is 1.02 to 1.

TABLE D-15

FIRST COST - HOP BROOK DAM AND RESERVOIR
(1958 Price Level)

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Lands and damages			L.S.	$	$1,222,000
Relocations					
Roads	2.12	mile	L.S.	312,000	
Contingencies				62,000	
Total					374,000
Reservoir					
Clearing	40	acre	$350	14,000	
Contingencies				3,000	
Total					17,000
Dam					
Preparation of site	10	acre	500	5,000	
Stream control			L.S.	10,000	
Earth excavation (common)	16,000	c.y.	0.90	14,400	
Earth excavation (borrow)	129,428	c.y.	0.70	90,600	
Rock excavation (open cut)	22,400	c.y.	3.50	78,400	
Embankment (placing and rolling)	129,000	c.y.	0.30	38,700	
Rockfill (placing only)	18,000	c.y.	0.80	14,400	

(R 12/31/58)

TABLE D-15 (Cont.)

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Dam, Cont.					
Concrete, mass	4,109	c.y.	$35	$143,800	$
Concrete, reinf.	560	c.y.	70	39,200	
Conduit, complete			L.S.	57,000	
Operating house superstructure	1,440	c.f.	2.50	3,600	
Service bridge	2,030	s.f.	$20	40,600	
Miscellaneous items				53,600	
Contingencies				117,700	
Total					707,000
Buildings, grounds, and utilities			L.S.		4,000
Total direct costs					$2,324,000
Indirect costs					
Preauthorization studies				20,000	
Engineering and design (14%)				155,000	
Supervision and administration (8%)				101,000	
Total indirect costs					276,000
Total project first cost					$2,600,000

(R 12/31/58)

TABLE D-16

ANNUAL CHARGES - HOP BROOK DAM AND RESERVOIR
(1958 Price Level)

Federal investment		
Federal first cost	$2,600,000	
Interest during construction	65,000	
Gross Federal investment	2,665,000	
Salvage value of land	- 177,000	
Net Federal investment	2,488,000	
Annual charges		
Federal		
Interest ($2,665,000 x 2.5%)	66,600	
Amortization ($2,488,000 x 1.026%)	25,500	
Maintenance and operation	10,000	
Total Federal annual charges		$102,100
Non-Federal		
Loss of taxes on land		11,100
Total annual charges		$113,200

(R 12/31/58)

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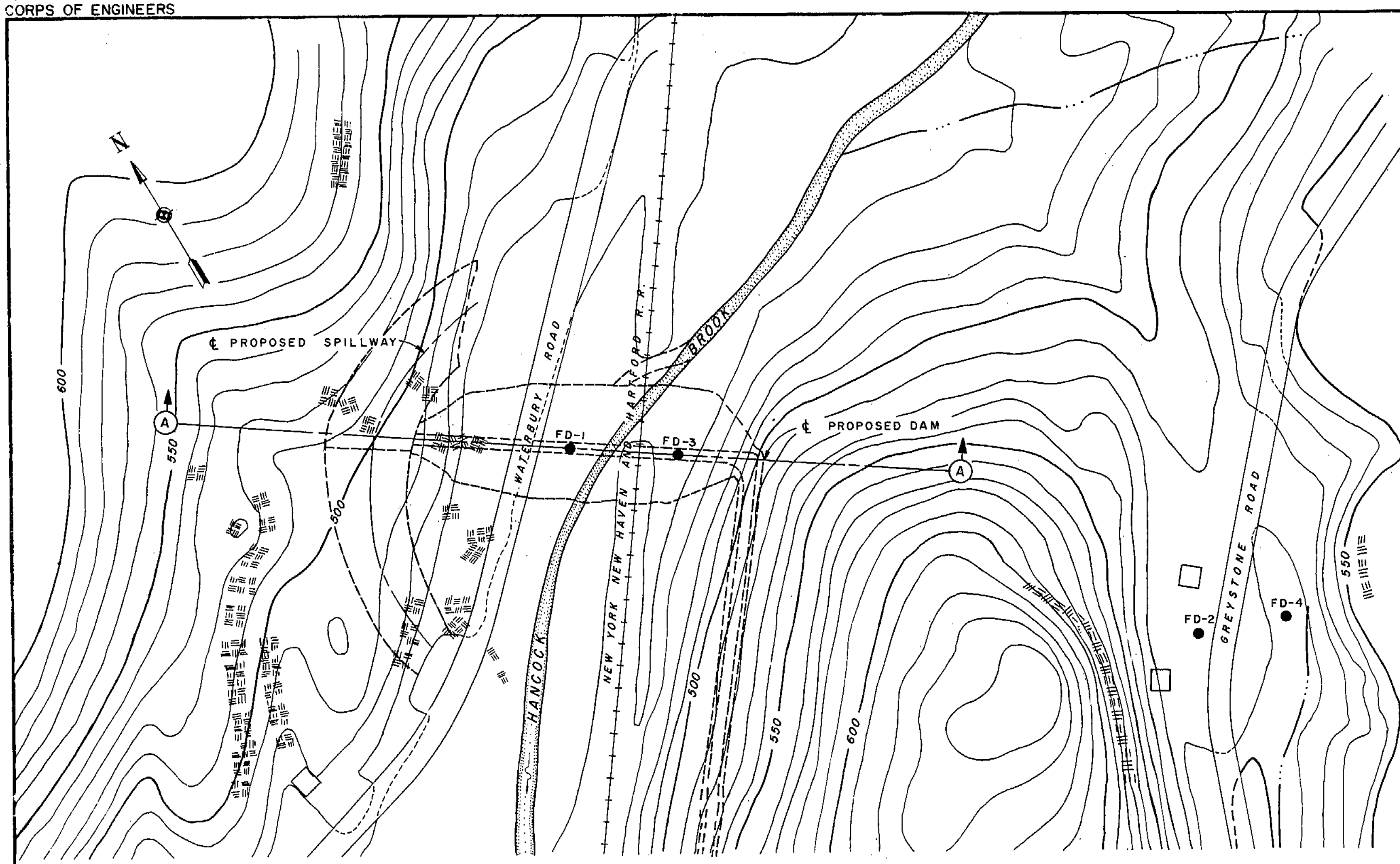
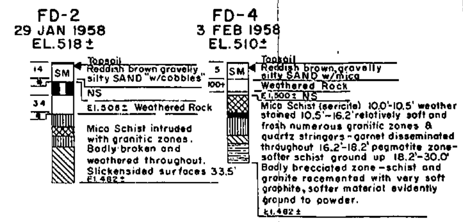


PLAN

TOPOGRAPHY ENLARGED FROM U.S.G.S. QUADRANGLE MAP

SCALE IN FEET

100' 0 100' 200'



NOTE:

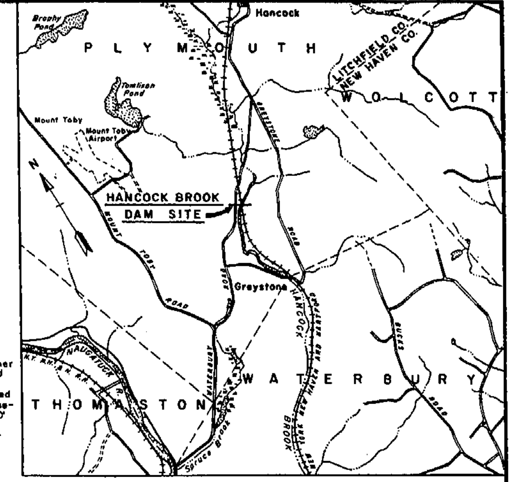
Borings FD-2 and FD-4 located in originally proposed remote spillway.

LEGEND FOR PLAN

FD-1 ● *Foundation Test Boring*

Ⅲ☰Ⅲ *Bedrock Outcrop*

Ⓐ—Ⓐ *Location of Geologic Log Profile*



GENERAL LOCATION MAP

SCALE IN MILES

1 mi. 1/2 mi. 0 1 mi.

LEGEND FOR GRAPHIC LOGS

FD-3 Foundation Test Boring

6 FEB 1958 Date exploration completed

EL. Elevation of ground surface during time of exploration

◄ Subsurface water level in boring at time of exploration

SC Group letter symbol according to Unified Soil Classification System

NR No Recovery or unsatisfactory soil samples recovered

NS Not Sampled (Core-drilled, blasted and/or washed-bored)

60 Blows per foot of penetration considered most representative, usually within a 5 foot drive using a 350 pound hammer with a free fall of about 18 inches on a 2" to 3" O.D. size sample spoon equipped with beveled and sharpened drive shoe

* Blow count not recorded or not considered representative

Cobble or boulder (Core-drilled)

Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped)

El.423± Elevation of bedrock surface

Rock core recovery 0-25 %

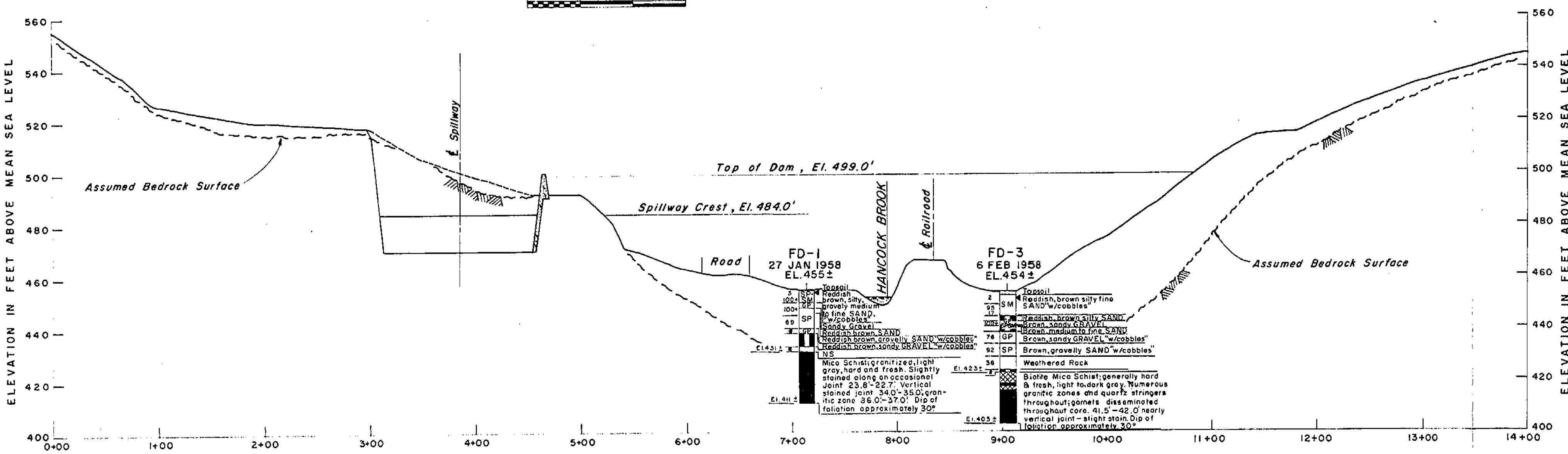
Rock core recovery 25-50 %

Rock core recovery 50-75 %

Rock core recovery 75-90 %

Rock core recovery 90-100%

El.403± Elevation at bottom of exploration



GEOLOGIC - LOG PROFILE

(LOOKING UPSTREAM)

PROFILE SURVEYED BY USCE, 1958.

NOTES:

Elevations refer to Mean Sea Level Datum.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

PREPARED BY C.G.H.
DRAWN BY: R.D.B.
CHECKED BY R.C.G.
CHIEF NED LABORATORIES
W. A. Tagle, Jr.
PROJECT ENGINEER
SUBMITTED BY
J. C. Dingwall
CHIEF, PLANN & REP'TS BRANCH
APPROVED
John Wm. Leslie
CHIEF ENGINEERING DIV
APPROVED
Raymond A. Seifert
LT. COL., C.E. EXECUTIVE OFFICER

HOUSATONIC RIVER FLOOD CONTROL
HANCOCK BROOK DAM
GEOLOGY

NAUGATUCK RIVER, CONNECTICUT

DATE MAY 1958

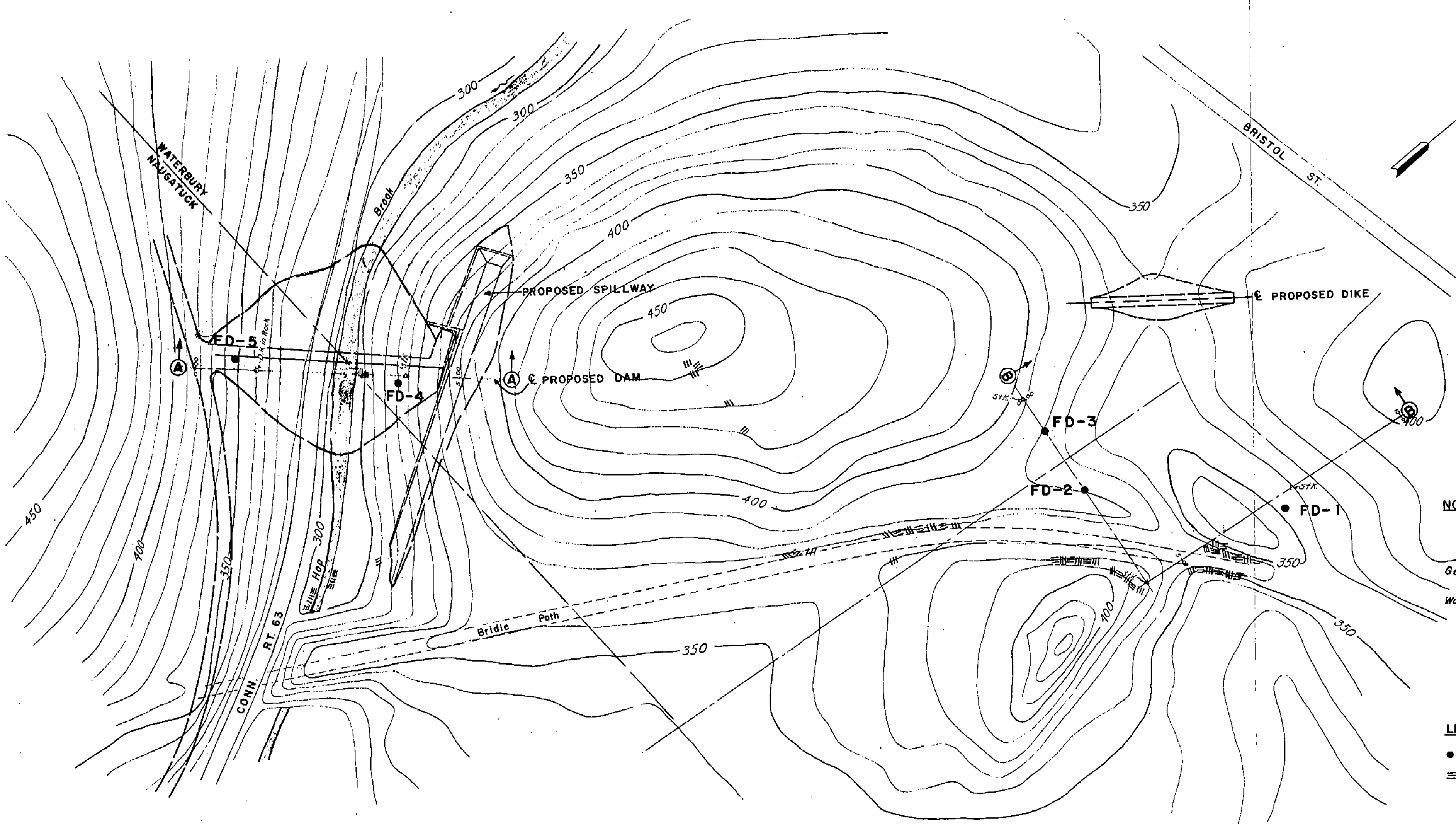
SCALE: AS SHOWN

TO ACCOMPANY REPORT DATED: 30 JUNE 1958

DRAWING NUMBER HC-1—1330

SHEET 1 OF 1

PLATE NO. D-1



NOTES:

Elevations refer to Mean Sea Level Datum.

Contour interval is 10 feet.

For Geologic-Log Sections A-A & B-B, see Geology sheet.

Topography based on U.S. Geological Survey, Waterbury Quadrangle, Connecticut.

LEGEND

● FD-1 Foundation Test Boring

Approximate location of bedrock exposures

PLAN

SCALE IN FEET

100' 0' 100' 200'

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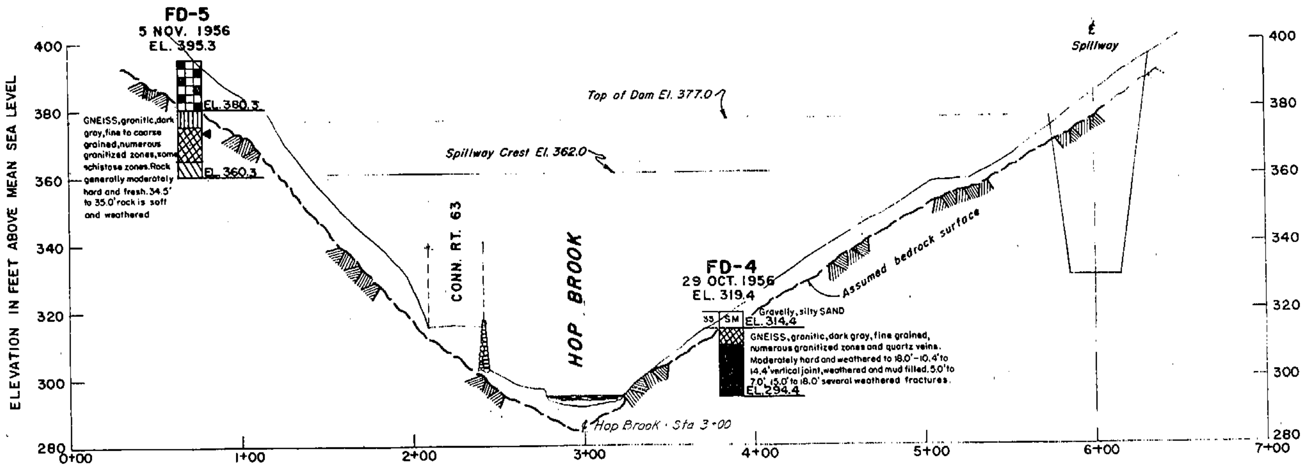
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY	TR. BY	CK. BY	
LB	LB		HOUSATONIC RIVER FLOOD CONTROL
K.A. Linell — CHIEF, N.E.D. LABORATORIES			HOP BROOK DAM
W.A. [illegible] — PROJECT ENGINEER			PLAN OF EXPLORATIONS
SUBMITTED BY: [signature] — CHIEF, PLANN. & RPTS. BRANCH			NAUGATUCK RIVER CONNECTICUT
APPROVED: John Wm. Leslie — CHIEF, ENGINEERING DIV.	APPROVED: Raymond A. [illegible] — LT. COL., C.E. EXECUTIVE OFFICER		DATE
			SCALE AS SHOWN
TO ACCOMPANY REPORT DATED: 30 JUNE 1958			DRAWING NUMBER HC-1-1331 SHEET 1 OF 1

CORPS OF ENGINEERS

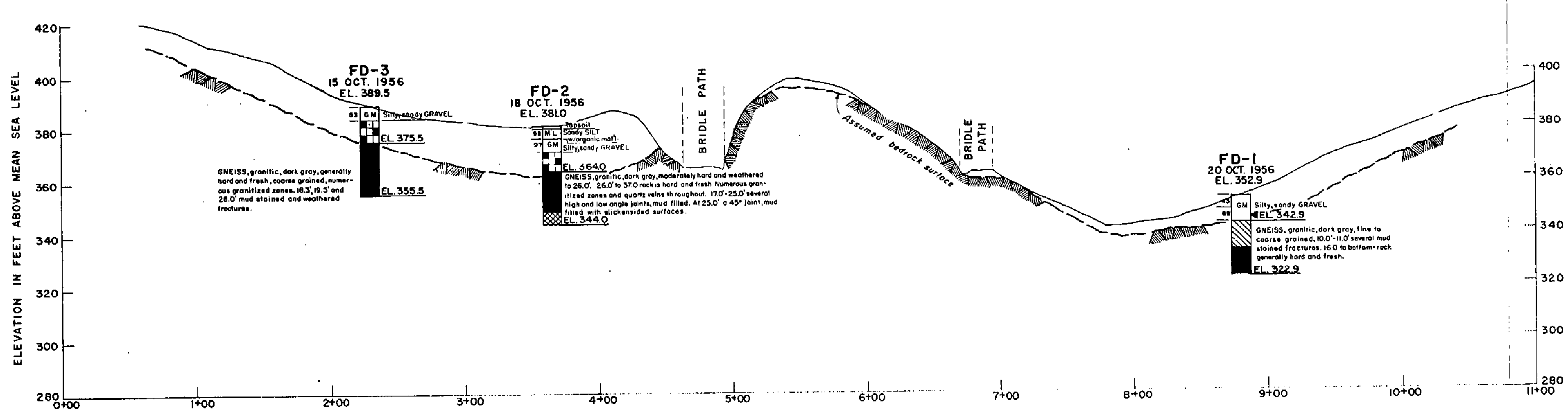
U.S. ARMY



GEOLOGIC-LOG SECTION A-A

(LOOKING UPSTREAM)

SCALE: HOR. 1" = 40'
VERT. 1" = 20'

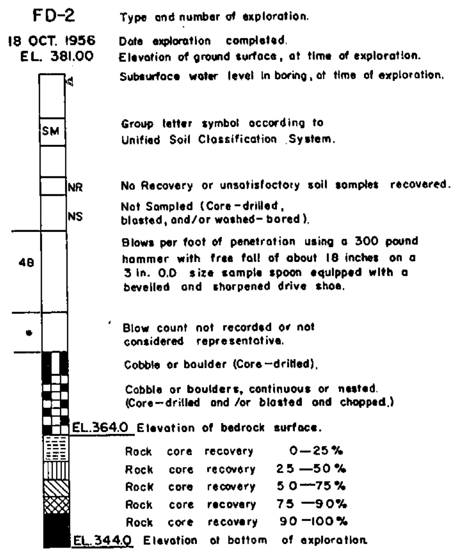


GEOLOGIC-LOG SECTION B-B

(LOOKING NORTH)

SCALE: HOR. 1" = 40'
VERT. 1" = 20'

LEGEND FOR GRAPHIC LOGS



NOTES:

Elevations refer to Mean Sea Level Datum.

For record and location of all explorations and location of geologic section, see Plan of Explorations.

Elevations for sections A-A and B-B are based on field survey.

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS

DR. BY	TR. BY	CK. BY

K.A. Lund
CHIEF, N.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY:
CHIEF, F.M. BR.
APPROVED:
CHIEF, ENGINEERING DIV.

HOUSATONIC RIVER FLOOD CONTROL

HOP BROOK DAM

GEOLOGY

NAUGATUCK RIVER — CONNECTICUT

APPROVED: Raymond A. Seifert
LT. COL., C.E. EXECUTIVE OFFICER

DATE JUNE 1958

SCALE: AS SHOWN

TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

DRAWING NUMBER
HC-1-1332

SHEET 1 OF 1

PLATE NO. D-3

APPENDIX E

OTHER PROJECTS STUDIED

APPENDIX E

OTHER PROJECTS STUDIED

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PLATES

APPENDIX E

OTHER PROJECTS STUDIED

TABLES

APPENDIX E

OTHER PROJECTS STUDIED

1. GENERAL

a. Dams and reservoirs. Five dam and reservoir projects were studied in addition to the four projects recommended in the report. Four of these 5 are economically not justified at this time. The fifth project - Branch Brook - was a more expensive alternative to the recommended Black Rock project. Descriptions of pertinent features of these projects, together with estimates of first costs and annual charges, are given in this appendix.

b. Local protection works. Five areas were studied for possible local protection works, 3 in Waterbury, and 2 in Ansonia. None of these 5 are economically justified at this time. Descriptions of these projects, together with estimates of first costs and annual charges, are given in this appendix.

2. BRANCH BROOK DAM AND RESERVOIR

The Branch Brook Dam site is located on Branch Brook in the town of Thomaston, Conn., approximately 0.9 mile upstream of the confluence of Branch Brook and the Naugatuck River. This project was studied as an alternative to the Black Rock project. The reservoir at spillway crest would be 1.4 miles long, lying within the town of Thomaston, Conn., and Watertown, Conn., and has a surface area of 280 acres. The reservoir would have a capacity of 10,000 acre-feet of storage, all reserved for flood control, equivalent to 8.4 inches of runoff from the net drainage area of 22.80 square miles. The limits of the reservoir are shown on Plate No. E-1 of this appendix.

The dam, with top elevation of 429 feet, mean sea level datum, would be of earth fill construction, approximately 1,050 feet long, with a maximum height of 89 feet above the stream bed. An L-shaped side-channel spillway at elevation 414, mean sea level datum, 750 feet long, would be constructed in rock in the left abutment. The spillway is designed for a 10-foot surcharge. A 54-inch reinforced concrete pipe, encased in concrete, would be constructed at the left of the stream bed and would discharge into Branch Brook immediately downstream from the dam. Control of flows through the conduit would be by means of 2-3'x3' hydraulically operated gates.

A dike would be necessary to protect the Reynolds Bridge section of Thomaston. The dike, with top elevation of 429 feet, mean sea level datum, would be of earth fill construction, approximately 2,200 feet long with a maximum height of 61 feet. A general plan and details of the dam are shown on Plate No. E-2 of this appendix. A breakdown of major construction items, together with their costs, is given in Table E-1 of this appendix; annual charges are given in Table E-2.

Annual benefits to the project, in a 7-reservoir system in lieu of the Black Rock project, are $227,000. As the last reservoir in the system, benefits are $185,000. Benefit:cost ratios for these two conditions are 1.12 and 0.91 to 1, respectively. Since benefits are the same for this project and the recommended Black Rock project on the same stream and costs favored the latter project, no further consideration was given this reservoir.

TABLE E-1

FIRST COST - BRANCH BROOK DAM AND RESERVOIR
(1958 Price Level)

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Lands and damages			L.S.		$1,716,000
Relocations					
Roads	2.8	mile	$175,000	$490,000	
Utilities			L.S.	50,000	
Contingencies				108,000	
Total					648,000
Reservoir					
Clearing	50	acre	350.00	17,500	
Contingencies				3,500	
Total					21,000
Dam					
Preparation of site	24	acre	600.	14,400	
Stream control			L.S.	10,000	
Earth excavation	435,000	c.y.	0.60	261,000	
Earth excavation (borrow)	443,900	c.y.	0.60	266,340	
Rock excavation (borrow)	27,400	c.y.	3.50	95,900	
Rock excavation	35,000	c.y.	3.50	122,500	
Embankment (rolled)	776,500	c.y.	0.25	194,100	
Select gravel	49,500	c.y.	2.00	98,000	
Rockfill	78,000	c.y.	0.60	46,800	
Concrete, mass	1,270	c.y.	40.00	50,800	
Conduit complete				130,525	
Miscellaneous items				128,635	
Contingencies				284,000	
Total					1,703,000
Access road	.5	mile	50,000	25,000	
Contingencies				5,000	
Total					30,000
Buildings, grounds, and utilities					
Minor appurtenances					5,000
Total direct costs					4,123,000
Indirect Costs					
Preauthorization studies				10,000	
Engineering and design (12%)				289,000	
Supervision and administration (8%)				216,000	
Total indirect costs					515,000
Total project first cost					4,638,000

TABLE E-2

ANNUAL CHARGES - BRANCH BROOK DAM AND RESERVOIR
(1958 Price Level)

FEDERAL INVESTMENT

Federal first costs	$4,638,000
Interest during construction	116,000
Gross Federal investment	$4,754,000
Salvage value of land	- 174,000
Net Federal investment	$4,579,000

ANNUAL CHARGES

Federal		
Interest ($4,754,000 x 2.5%)	$119,000	
Amortization ($4,579,000 x 1.026%)	47,000	
Maintenance and operation	11,000	
Total Federal annual charges		$177,000
Non-Federal		
Loss of taxes on land		26,500
Total annual charges		$203,500

3. SCOVILL DAM AND RESERVOIR

The Scovill Dam site is located on the Mad River in the town of Wolcott, Conn., approximately 0.7 mile upstream of the confluence of the Mad River and Lily Brook. The project would flood out the existing reservoir of the Scovill Manufacturing Company of Waterbury. The reservoir at spillway crest would extend 1.1 miles up the Mad River, lying entirely within the town of Wolcott, and would have a surface area of 240 acres. The reservoir would have a capacity of 4,800 acre-feet of storage divided into 3,720 acre-feet for flood storage, equivalent to 8.5 inches of runoff, and 1,080 acre-feet for a permanent pool to replace the existing storage, equivalent to 2.5 inches of runoff from the net drainage area of 8.24 square miles. The limits of the reservoir are shown on Plate No. E-3 of this appendix.

The dam, with top elevation of 565, mean sea level datum, would be of earth fill construction, approximately 5,200 feet long, with a maximum height of 60 feet above the stream bed. A chute spillway at elevation 550.0, mean sea level datum, 100 feet long, would be constructed in rock immediately downstream from the existing Scovill Dam. The spillway is designed for a 10-foot surcharge. A 54-inch reinforced concrete pipe would be constructed through the spillway. Two 3'x3' hydraulically-operated gates would control the discharge into the Mad River immediately downstream from the dam.

A dike would be required to protect low lands around Route 69. The dike, with top elevation of 565.0, mean sea level datum, would be of earth fill construction, approximately 1,230 feet long with a maximum height of 30 feet. A general plan and details of the dam are shown on Plate No. E-4 of this appendix. A breakdown of major construction items, together with their costs, is given in Table E-3; annual charges are given in Table E-4.

Benefits to the project, as the first reservoir after Thomaston, are $105,500, resulting in a benefit:cost ratio of 0.74 to 1. Since this is the most favorable basis for justification, no further consideration was given this project.

TABLE E-3

FIRST COST - SCOVILL DAM, DIKE AND RESERVOIR
(1958 Price Level)

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Lands and damages			L.S.		$ 634,000
Relocations					
Roads	0.8	mile	L.S.	$ 74,000	
Utilities			L.S.	20,000	
Contingencies				19,000	
Total					113,000
Reservoir					
Clearing	10	acre	$350.	3,500	
Contingencies				500	
Total					4,000
Dam					
Preparation of site	18	acre	600.	10,800	
Stream control			L.S.	5,000	
Earth excavation	1,000	c.y.	0.90	900	
Earth excavation (borrow)	678,250	c.y.	0.60	407,000	
Rock excavation (borrow)	68,800	c.y.	3.00	206,400	
Embankment (rolled)	588,000	c.y.	0.25	147,000	
Select gravel	62,000	c.y.	2.00	124,000	
Rockfill	86,000	c.y.	0.60	51,600	
Concrete, mass	22,000	c.y.	30.00	660,000	
Concrete, reinforced	50	c.y.	70.00	3,500	
Gates and machinery			L.S.	25,000	
Operating house superstructure			L.S.	25,000	
Miscellaneous items				166,800	
Contingencies				367,000	
Total					2,200,000
Access road	0.2	mile	50,000	10,000	
Contingencies				2,000	
Total					12,000
Buildings, grounds, and utilities					
Electric service lines			L.S.	5,000	
Grading and landscaping			L.S.	5,000	
Contingencies				2,000	
Total					12,000
Total direct costs					2,975,000
Indirect costs					
Preauthorization studies				10,000	
Engineering and design (12%)				281,000	
Supervision and administration (8%)				210,000	
Total indirect costs					501,000
Total project first cost					$3,476,000

TABLE E-4

ANNUAL CHARGES - SCOVILL DAM, DIKE AND RESERVOIR
(1958 Price Level)

FEDERAL INVESTMENT

Federal first costs	$3,476,000
Interest during construction	87,000
Gross Federal investment	3,563,000
Salvage value of land	- 90,000
Net Federal investment	$3,473,000

ANNUAL CHARGES

Federal		
Interest ($3,563,000 x 2.5%)	$ 89,100	
Amortization ($3,473,000 x 1.026%)	35,600	
Maintenance and operation	10,000	
Total Federal annual charges		$134,700
Non-Federal		
Loss of taxes on land		7,000
Total annual charges		$141,700

4. MEADOW POND BROOK DAM AND RESERVOIR

The Meadow Pond Brook Dam site is located on Meadow Pond Brook in the towns of Naugatuck and Middlebury, Conn., approximately 1.9 miles upstream of its confluence with the Naugatuck River. The reservoir at spillway crest would extend 1.5 miles up Meadow Pond Brook, lying within the towns of Naugatuck and Middlebury, and have a surface area of 115 acres. The reservoir would have a capacity of 2,090 acre-feet of storage, all reserved for flood control, equivalent to 6.0 inches of runoff from the net drainage area of 6.54 square miles. The limits of the reservoir are shown on Plate No. E-5 of this appendix.

The dam, with top elevation of 439.0 feet, mean sea level datum, would be of earth fill construction, approximately 4,900 feet long with a maximum height of 68 feet above the stream bed. A side-channel spillway at elevation 424.0, mean sea level datum, 130 feet long, would be constructed in rock in the right abutment. The spillway is designed for a 10-foot surcharge. A 36-inch reinforced concrete pipe, encased in concrete, would be constructed at the left of the stream bed and discharge into Meadow Brook immediately downstream from the dam.

A dike would be required to protect the low lands near Allerton Farm Road. The dike, with top elevation of 439.0 feet, mean sea level datum, would be of earth fill construction, approximately 7,250 feet long with a maximum height of 19 feet. A general plan and details of the dam are shown on Plate No. E-6 of this appendix. A breakdown of major construction items, together with their costs, is given in Table E-5; annual charges are given in Table E-6.

Benefits to the project, as the first reservoir after Thomaston, are $66,900, resulting in a benefit:cost ratio of 0.83 to 1. Since this is the most favorable basis for justification, no further consideration was given this project.

TABLE E-5

FIRST COST - MEADOW POND BROOK DAM AND RESERVOIR
(1958 Price Level)

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Lands and damages			L.S.		$ 605,000
Relocations					
Roads	1.4	mile	L.S.	$200,000	
Utilities			L.S.	40,000	
Contingencies				48,000	
Total					288,000
Reservoir					
Clearing	10	acre	$350.	3,500	
Contingencies				500	
Total					4,000
Dam					
Preparation of site	9	acre	600	5,400	
Stream control			L.S.	5,000	
Earth excavation	21,000	c.y.	0.70	14,700	
Earth excavation (borrow)	73,000	c.y.	0.70	51,100	
Rock excavation	53,300	c.y.	3.00	159,900	
Embankment (rolled)	108,000	c.y.	0.30	32,400	
Select gravel	10,200	c.y.	2.50	25,500	
Rockfill	15,500	c.y.	0.80	12,400	
Concrete, mass	5,000	c.y.	35.00	175,000	
Conduit			L.S.	60,000	
Miscellaneous items				54,100	
Contingencies				119,500	
Total					715,000
Access road			L.S.	5,000	
Contingencies				1,000	
Total					6,000
Buildings, grounds, and utilities					
Minor appurtenances					5,000
Total direct costs					1,623,000
Indirect costs					
Preauthorization studies				10,000	
Engineering and design (16%)				163,000	
Supervision and administration (8%)				94,000	
Total indirect costs					267,000
Total project first cost					$1,890,000

TABLE E-6

ANNUAL CHARGES - MEADOW POND BROOK DAM AND RESERVOIR
(1958 Price Level)

FEDERAL INVESTMENT

Federal first costs	$1,890,000
Interest during construction	47,000
Gross Federal investment	$1,937,000
Salvage value of land	-100,000
Net Federal investment	$1,837,000

ANNUAL CHARGES

Federal		
Interest ($1,937,000 x 2.5%)	$48,400	
Amortization ($1,837,000 x 1.026%)	18,800	
Maintenance and operation	10,000	
Total Federal annual charges		$77,200
Non-Federal		
Loss of taxes on land		3,500
Total annual charges		$80,700

5. BLADENS RIVER DAM AND RESERVOIR

The Bladens River Dam site is located on Bladens River in the town of Seymour, Conn., approximately 1.0 miles upstream of its confluence with the Naugatuck River. The reservoir at spillway crest would extend 1.9 miles up Bladens Brook, 0.6 miles up Hopp Brook, 0.6 miles up Black Brook, and 0.5 miles up an unnamed tributary. At spillway crest, the reservoir would lie within the towns of Bethany, Seymour, and Woodbridge, Conn., and have a surface area of 240 acres. The reservoir would have a capacity of 6,000 acre-feet of storage, all reserved for flood control equivalent to 11.25 inches of runoff from the net drainage area of 9.97 square miles. The limits of the reservoir are shown on Plate No. E-7 of this appendix.

The dam, with top elevation of 290 feet, mean sea level datum, would be of earth fill construction, approximately 1,950 feet long with a maximum height of 107 feet above the stream bed. A chute spillway at elevation 275.0, mean sea level datum, 150 feet long, would be constructed in rock in the right abutment. The spillway is designed for a 10-foot surcharge. A 42-inch reinforced concrete pipe, encased in concrete, would be constructed at the right of the stream bed and discharge into Bladens River immediately downstream from the dam.

A dike would be required to protect a cemetery near Black Brook. The dike, with top elevation of 290 feet, mean sea level datum, would be of earth fill construction, approximately 1,100 feet long, with a maximum height of 30 feet. A general plan and details of the dam are shown on Plate E-8 of this appendix. A breakdown of major construction items, together with their costs, is given in Table E-7; annual charges are given in Table E-8.

Benefits to this project, as the first reservoir after Thomaston, are $25,800 resulting in a benefit:cost ratio of 0.15 to 1. Since this is the most favorable basis for justification, no further consideration was given this project.

TABLE E-7

FIRST COST - BLADENS RIVER DAM AND RESERVOIR
(1958 Price Level)

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Lands and damages			L.S.		$1,230,000
Relocations					
Roads	3.0	mile	L.S.	$590,000	
Contingencies				100,000	
Total					690,000
Reservoir					
Clearing	20	acre	$350.	7,000	
Contingencies				2,000	
Total					9,000
Dam					
Preparation of site	18	acre	600.	10,800	
Stream control	1		L.S.	6,000	
Earth excavation	305,000	c.y.	0.60	183,000	
Earth excavation (borrow)	160,000	c.y.	0.60	96,000	
Rock excavation	6,200	c.y.	4.00	24,800	
Rock excavation (borrow)	43,800	c.y.	3.50	153,300	
Embankment (rolled)	422,000	c.y.	0.30	126,600	
Select gravel	15,200	c.y.	2.50	38,000	
Rockfill	57,500	c.y.	0.60	34,500	
Concrete, mass	12,700	c.y.	30.00	381,000	
Concrete, reinforced	500	c.y.	70.00	35,000	
Conduit	1		L.S.	151,300	
Miscellaneous items				124,700	
Contingencies				273,000	
Total					1,638,000
Access road			L.S.	3,000	
Contingencies				1,000	
Total					4,000
Total direct costs					3,571,000
Indirect costs					
Preauthorization studies				20,000	
Engineering and design (13%)				305,000	
Supervision and administration (8%)				212,000	
Total indirect costs					537,000
Total project first cost					$4,108,000

TABLE E-8

ANNUAL CHARGES - BLADENS RIVER DAM AND RESERVOIR
(1958 Price Level)

FEDERAL INVESTMENT

Federal first costs	$4,108,000
Interest during construction	103,000
Gross Federal investment	$4,211,000
Salvage value of land	- 190,000
Net Federal investment	$4,021,000

ANNUAL CHARGES

Federal		
Interest ($4,211,000 x 2.5%)	$ 105,000	
Amortization ($4,021,000 x 1.026%)	41,000	
Maintenance and operation	10,000	
Total Federal annual charges		$156,000
Non-Federal		
Loss of taxes on land		18,500
Total annual charges		$174,500

6. LITTLE RIVER DAM AND RESERVOIR

The Little River Dam site is located on the Little River in the town of Oxford, Conn., approximately 2.3 miles upstream of its confluence with the Naugatuck River. The reservoir at spillway crest would extend 1.3 miles up the Little River, lying within the town of Oxford, and have a surface area of 128 acres. The reservoir would have a capacity of 4,620 acre-feet of storage, all reserved for flood control, equivalent to 7.1 inches of runoff from the net drainage area of 12.20 square miles. The limits of the reservoir are shown on Plate No. E-9 of this appendix.

The dam, with top elevation of 356 feet, mean sea level datum, would be of earth fill construction, approximately 560 feet long with a maximum height of 112 feet above the stream bed. A side-channel spillway at elevation 345.0, mean sea level datum, 310 feet long, would be constructed in rock in the right abutment. The spillway is designed for a 6-foot surcharge. A 42-inch reinforced concrete pipe, encased in concrete, would be constructed in the right bank of the stream bed and discharge into Little River immediately downstream from the dam. A general plan and details of the dam are shown on Plate No. E-10 of this appendix. A breakdown of major construction items, together with their costs, is given in Table E-9; annual charges are given in Table E-10.

Benefits to this project, as the first reservoir after Thomaston, are $35,100, resulting in a benefit:cost ratio of 0.32 to 1. Since this is the most favorable basis for justification, no further consideration was given this project.

TABLE E-9

FIRST COST - LITTLE RIVER DAM AND RESERVOIR
(1958 Price Level)

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Lands and damages			L.S.		$ 665,000
Relocations					
Roads	2.5	mile	L.S.	$450,000	
Utilities			L.S.	20,000	
Contingencies				94,000	
Total					564,000
Reservoir					
Clearing	10	acre	350.00	3,500	
Contingencies				500	
Total					4,000
Dam					
Preparation of site	8	acre	600.00	4,800	
Stream control			L.S.	7,000	
Earth excavation	245,000	c.y.	0.60	147,000	
Earth excavation (borrow)	102,500	c.y.	0.65	66,600	
Rock excavation	38,000	c.y.	3.50	133,000	
Embankment (rolled)	350,000	c.y.	0.30	105,000	
Select gravel	5,000	c.y.	3.00	15,000	
Rockfill	32,000	c.y.	0.60	19,200	
Concrete, mass	3,500	c.y.	35.00	122,500	
Concrete, reinforced	2,200	c.y.	60.00	132,000	
Conduit			L.S.	87,000	
Miscellaneous items				83,900	
Contingencies				185,000	
Total					1,108,000
Access road			L.S.	5,000	
Contingencies				1,000	
Total					6,000
Buildings, grounds, and utilities					
Minor appurtenances					5,000
Total direct costs					2,352,000
Indirect costs					
Preauthorization studies				10,000	
Engineering and design (14%)				236,000	
Supervision and administration (8%)				154,000	
Total indirect costs					400,000
Total project first cost					$2,752,000

TABLE E-10

ANNUAL CHARGES - LITTLE RIVER DAM AND RESERVOIR
(1958 Price Level)

FEDERAL INVESTMENT

Federal first costs	$2,752,000
Interest during construction	69,000
Gross Federal investment	$2,821,000
Salvage value of land	- 14,500
Net Federal investment	$2,806,500

ANNUAL CHARGES

Federal		
Interest ($2,821,000 x 2.5%)	70,500	
Amortization ($2,806,500 x 1.026%)	28,800	
Maintenance and operation	10,000	
Total Federal annual charges		$109,300
Non-Federal		
Loss of taxes on land		500
Total annual charges		$109,800

7. WATERBURY, CONN., LOCAL PROTECTION

Three contiguous areas on the left bank of the Naugatuck River in the high damage reach in Waterbury, Conn., were investigated for possible local protection. Area "A" extends from high ground 600 feet upstream from the intersection of West Main Street and Route 8 to the New York, New Haven and Hartford Railroad bridge over the Naugatuck River. Area "B" extends from the downstream abutment of the railroad bridge to the right bank of the Mad River. Area "C" extends from the left bank of the Mad River to a point on the Naugatuck River 1,000 feet upstream from the Eagle Street bridge. Tables E-11 through E-16 show estimates of first costs and annual charges for these three projects. None of these projects is economically justified by residual annual benefits after Thomaston Dam and the four reservoir projects recommended in this report. First costs for Area "A" are $838,500 with annual charges of $48,800. Annual losses in the area are $30,000. First costs for Area "B" are $756,000 with annual charges of $30,300. Benefits are estimated at $20,000 annually, resulting in a benefit-cost ratio of 0.66 to 1. First costs of Area "C" are $309,000, with annual charges of $16,700. Annual losses in the area are estimated at $15,000. First costs and annual charges for these projects are summarized in Tables E-11 through E-16.

TABLE E-11

WATERBURY LOCAL PROTECTION
AREA "A"
FIRST COSTS
(1958 Price Level)

Item	Quantity	Unit	Unit Price	Amount	Total
Federal first cost					
Preparation of site	10	acre	$300.	$ 3,000	
Borrow, common	51,000	c.y.	1.30	66,300	
" impervious	18,400	c.y.	1.30	23,900	
Gravel borrow	2,000	c.y.	3.00	6,000	
Riprap	3,900	c.y.	5.00	19,500	
Reinforced concrete	3,500	c.y.	100.	350,000	
Common excavation and backfill	4,400	c.y.	1.30	5,700	
Stoplog structure	1	Job	L.S.	4,000	
Loam	2,000	c.y.	4.00	8,000	
Seeding	4,000	s.y.	.10	400	
Drainage and pumping	1	Job	L.S.	75,000	
Subtotal				561,800	
Contingencies				112,200	
Total direct cost				674,000	
Preauthorization studies				1,000	
Engineering and design				81,000	
Supervision and administration				60,000	
Total Federal first costs					$ 816,000
Non-Federal first cost					
Lands, easements and right-of-way				22,500	
Total Non-Federal first cost					22,500

TABLE E-12

WATERBURY LOCAL PROTECTION
AREA "A"
ANNUAL CHARGES
(1958 Price Level)

FEDERAL INVESTMENT		
Federal first cost	$816,000	
Interest during construction	10,000	
Total Federal investment	$826,000	
FEDERAL ANNUAL CHARGES		
Interest	20,700	
Amortization	8,500	
Total Federal annual charges		$29,200
NON-FEDERAL INVESTMENT		
Non-Federal first costs	22,500	
Interest during construction	300	
Total Non-Federal investment	22,800	
NON-FEDERAL ANNUAL CHARGES		
Interest and amortization	800	
Maintenance and operation	3,000	
Net loss of taxes	1,600	
Total Non-Federal annual charges		5,400
Total annual charges		$34,600

(R 6/10/59)

TABLE E-13

WATERBURY LOCAL PROTECTION
AREA "B"
FIRST COSTS
(1958 Price Level)

Item	Quantity	Unit	Unit Price	Amount	Total
Federal first cost					
Preparation of site	4	acre	$300.	$ 1,200	
Reinforced concrete	4,062	c.y.	100.	406,200	
Common excavation and backfill	7,420	c.y.	1.30	9,700	
Stoplog structure	1	Job	L.S.	10,000	
Drainage and pumping	1	Job	L.S.	90,000	
Subtotal				517,100	
Contingencies				102,900	
Total direct cost				620,000	
Preauthorization studies				1,000	
Engineering and design				74,000	
Supervision and administration				56,000	
Total Federal first cost					$751,000
Non-Federal first cost					
Lands, easements and right-of-way				5,000	
Total Non-Federal first cost					5,000

TABLE E-14

WATERBURY LOCAL PROTECTION
AREA "B"
ANNUAL CHARGES
(1958 Price Level)

FEDERAL INVESTMENT

Federal first cost	$751,000	
Interest during construction	9,000	
Total Federal investment	$760,000	

FEDERAL ANNUAL CHARGES

Interest	19,000	
Amortization	7,800	
Total Federal annual charges		$26,800

NON-FEDERAL INVESTMENT

Non-Federal first costs	5,000	
Interest during construction	100	
Total Non-Federal investment	5,100	

NON-FEDERAL ANNUAL CHARGES

Interest and amortization	180	
Maintenance and operation	3,000	
Net loss of taxes	320	
Total Non-Federal annual charges		3,500
Total annual charges		$30,300

TABLE E-15

WATERBURY LOCAL PROTECTION
AREA "C"
FIRST COSTS
(1958 Price Level)

Item	Quantity	Unit	Unit Price	Amount	Total
Federal first cost					
Preparation of site	4	acre	$300.	$ 1,200	
Borrow, common	8,330	c.y.	1.30	10,830	
" impervious	3,170	c.y.	1.30	4,120	
" gravel	510	c.y.	3.00	1,530	
Riprap	1,010	c.y.	5.00	5,050	
Reinforced concrete	1,440	c.y.	100.	144,000	
Common excavation and backfill	2,000	c.y.	1.30	2,600	
Stoplog structure	1	Job	L.S.	2,000	
Loam	510	c.y.	4.00	2,040	
Seeding	1,100	s.y.	0.10	110	
Drainage and pumping	1	Job	L.S.	75,000	
Subtotal				248,480	
Contingencies				49,520	
Total direct cost				298,000	
Preauthorization studies				1,000	
Engineering and design				36,000	
Supervision and administration				27,000	
Total Federal first cost					$ 362,000
Non-Federal first cost					
Lands, easements, and right-of-way				11,000	
Total Non-Federal first cost					11,000

TABLE E-16

WATERBURY LOCAL PROTECTION
AREA "C"
ANNUAL CHARGES
(1958 Price Level)

FEDERAL INVESTMENT

Federal first cost	$362,000	
Interest during construction	5,000	
Total Federal investment	367,000	

FEDERAL ANNUAL CHARGES

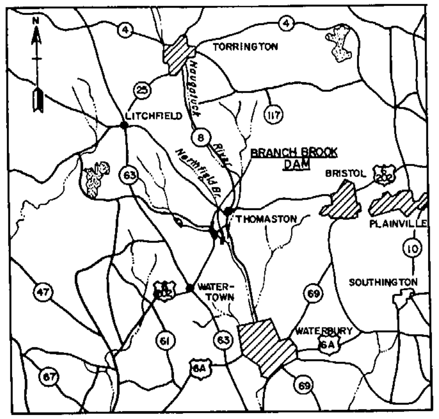
Interest	9,200	
Amortization	3,800	
Total Federal annual charges		$13,000

NON-FEDERAL INVESTMENT

Non-Federal first costs	11,000	
Interest during construction	140	
Total Non-Federal investment	11,140	

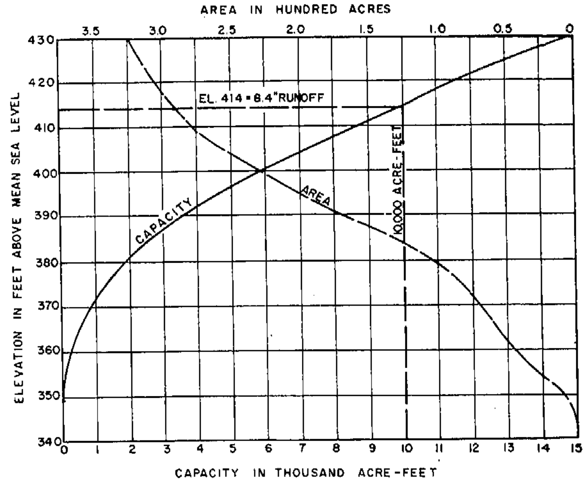
NON-FEDERAL ANNUAL CHARGES

Interest and amortization	400	
Maintenance and operation	2,500	
Net loss of taxes	800	
Total Non-Federal annual charges		3,700
Total annual charges		$16,700



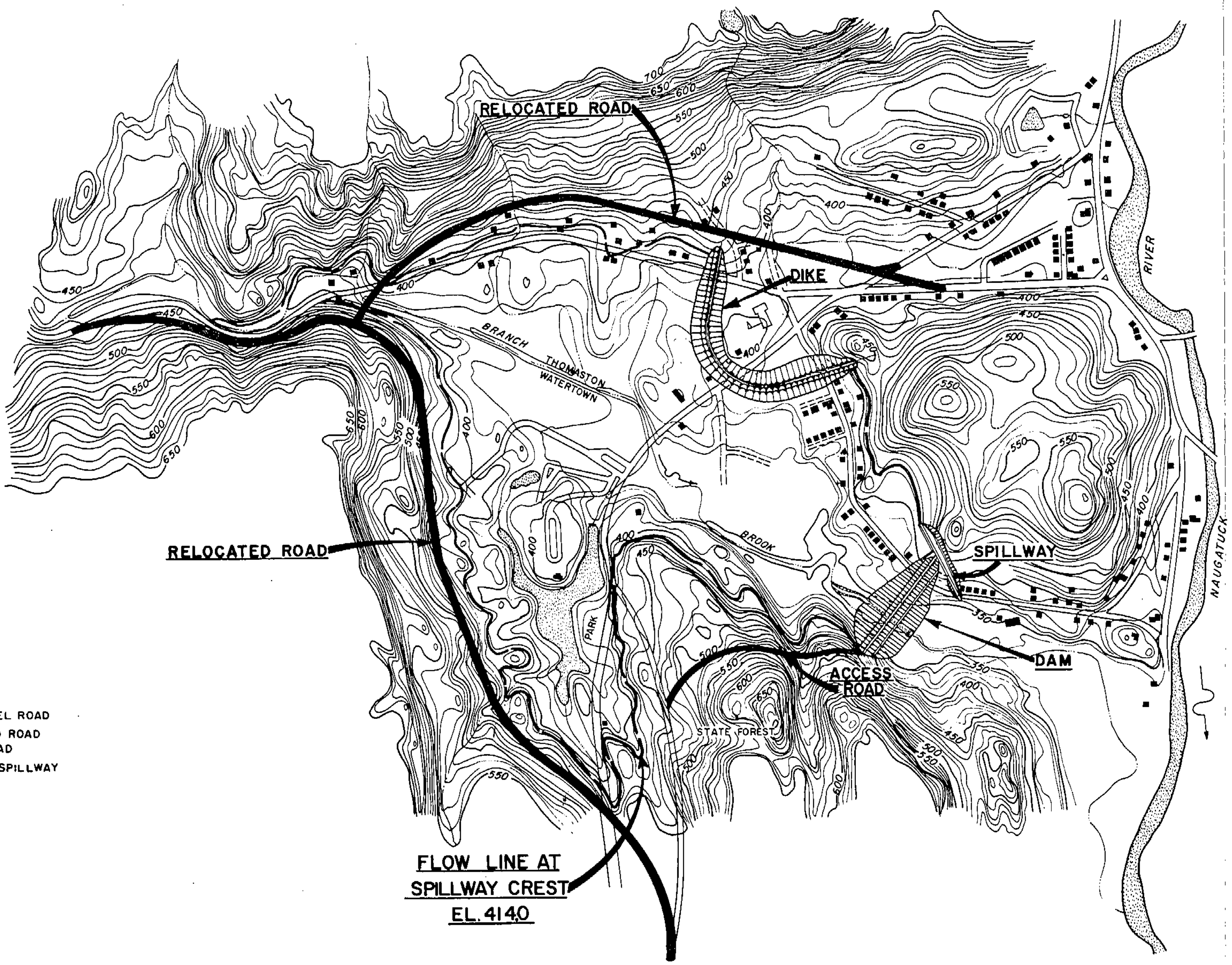
VICINITY MAP

SCALE IN MILES



AREA AND CAPACITY CURVES

(DAM) DRAINAGE AREA 22.80 SQ. MILES
(MOUTH) DRAINAGE AREA 23.00 SQ. MILES



PLAN

SCALE: 1" = 500'

NOTES:

Elevations refer to Mean Sea Level Datum.
Contour interval equals ten feet.
Topography is based on U.S.G.S. Map.

LEGEND

EXISTING GRAVEL ROAD
EXISTING PAVED ROAD
RELOCATED ROAD
RESERVOIR AT SPILLWAY CREST EL. 414.0

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY	TR. BY	CK. BY
R.J.O.	A.J.H.	J.W.D.

HOUSATONIC RIVER FLOOD CONTROL
BRANCH BROOK DAM
RESERVOIR MAP
NAUGATUCK RIVER CONNECTICUT

PROJECT ENGINEER
CHIEF, PLANN. & REPTS. BRANCH
APPROVED
CHIEF, ENGINEERING DIV.
APPROVED
EXECUTIVE OFFICER

DATE JUNE 1958

TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

SCALE: AS SHOWN
DRAWING NUMBER
HC-1-1333
SHEET 1 OF 1

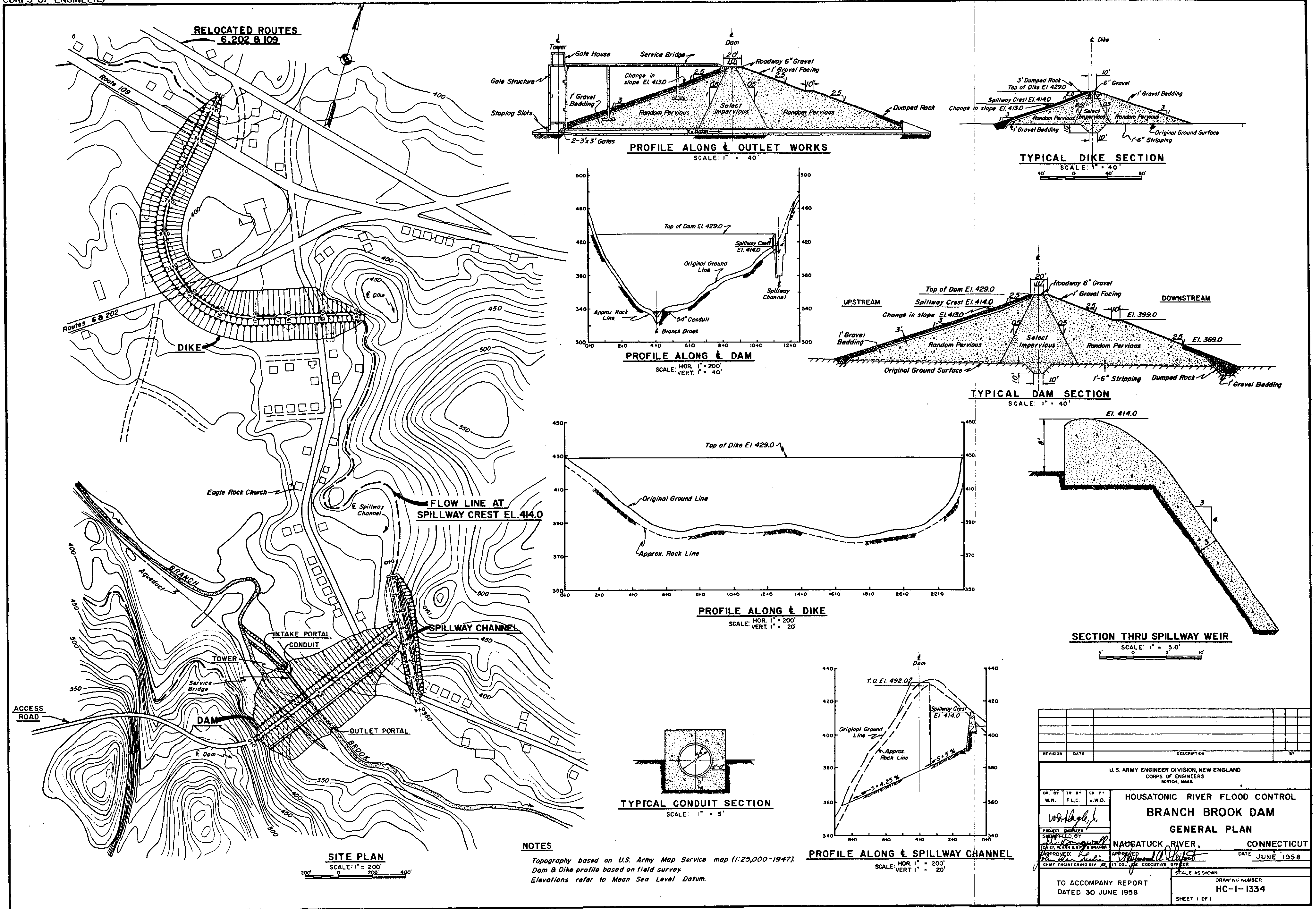
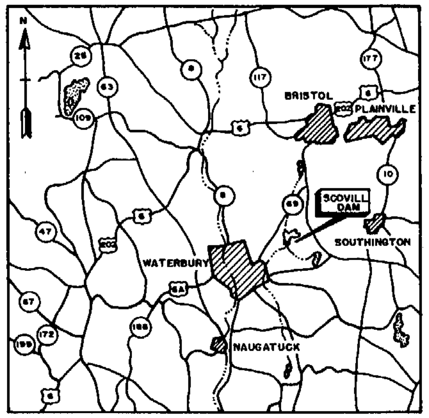

RELOCATED ROUTES 6,202 & 109
Route 109
Routes 6 & 202
DIKE
Eagle Rock Church
FLOW LINE AT SPILLWAY CREST EL. 414.0
℄ Spillway Channel
℄ Dike
BRANCH
Aqueduct
INTAKE PORTAL
CONDUIT
TOWER
Service Bridge
SPILLWAY CHANNEL
ACCESS ROAD
DAM
℄ Dam
OUTLET PORTAL
BROOK
SITE PLAN
SCALE: 1" = 200'
Tower
Gate House
Service Bridge
Gate Structure
Stoplog Slots
2-3'x3' Gates
1' Gravel Bedding
Change in slope El. 413.0
Roadway 6" Gravel
1' Gravel Facing
Random Pervious
Select Impervious
Dumped Rock
PROFILE ALONG ℄ OUTLET WORKS
SCALE: 1" = 40'
3' Dumped Rock
Top of Dike El. 429.0
6" Gravel
Spillway Crest El. 414.0
Change in slope El. 413.0
1' Gravel Bedding
Original Ground Surface
1'-6" Stripping
TYPICAL DIKE SECTION
SCALE: 1" = 40'
Top of Dam El. 429.0
Spillway Crest El. 414.0
Original Ground Line
Spillway Channel
Approx. Rock Line
54" Conduit
℄ Branch Brook
PROFILE ALONG ℄ DAM
SCALE: HOR. 1" = 200' VERT. 1" = 40'
UPSTREAM
DOWNSTREAM
Top of Dam El. 429.0
Spillway Crest El. 414.0
Change in slope El. 413.0
Roadway 6" Gravel
1' Gravel Facing
El. 399.0
El. 369.0
1' Gravel Bedding
Random Pervious
Select Impervious
Original Ground Surface
1'-6" Stripping
Dumped Rock
TYPICAL DAM SECTION
SCALE: 1" = 40'
Top of Dike El. 429.0
Original Ground Line
Approx. Rock Line
PROFILE ALONG ℄ DIKE
SCALE: HOR. 1" = 200' VERT. 1" = 20'
El. 414.0
SECTION THRU SPILLWAY WEIR
SCALE: 1" = 5.0'
TYPICAL CONDUIT SECTION
SCALE: 1" = 5'
T.D. El. 492.0
Spillway Crest El. 414.0
Original Ground Line
Approx. Rock Line
S = 4.25 %
S = 5 %
PROFILE ALONG ℄ SPILLWAY CHANNEL
SCALE: HOR. 1" = 200' VERT 1" = 20'
NOTES
Topography based on U.S. Army Map Service map (1:25,000-1947).
Dam & Dike profile based on field survey.
Elevations refer to Mean Sea Level Datum.
REVISION DATE DESCRIPTION BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.
HOUSATONIC RIVER FLOOD CONTROL
BRANCH BROOK DAM
GENERAL PLAN
NAUGATUCK RIVER, CONNECTICUT
DATE JUNE 1958
SCALE AS SHOWN
TO ACCOMPANY REPORT DATED: 30 JUNE 1958
DRAWING NUMBER HC-1-1334
SHEET 1 OF 1

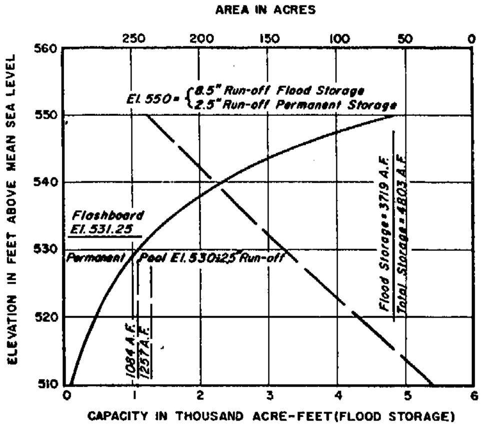
PLATE NO. E-2



VICINITY MAP

SCALE IN MILES

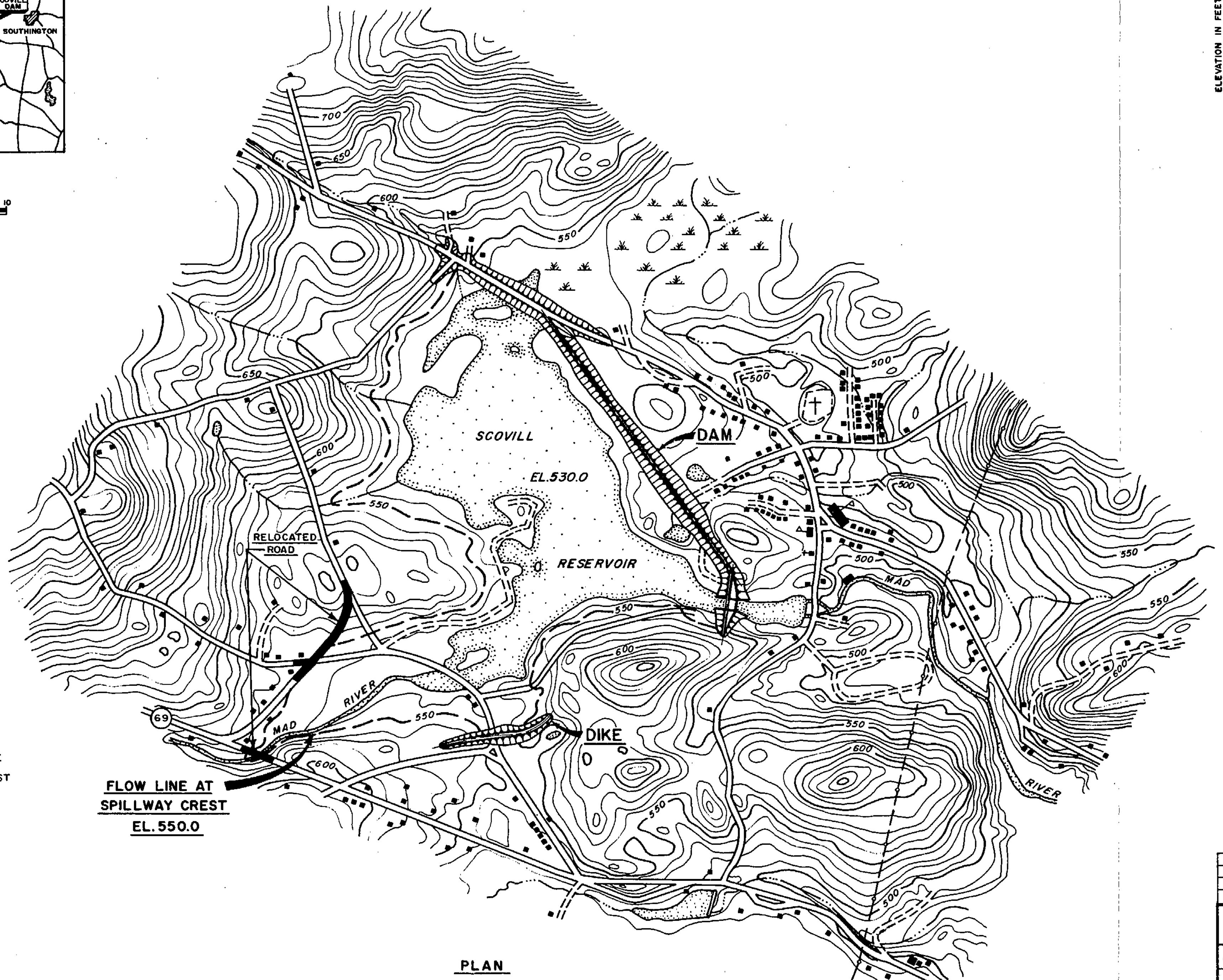
5 0 5 10



AREA AND CAPACITY CURVES

(DAM) DRAINAGE AREA 8.24 SQ. MILES

(MOUTH) DRAINAGE AREA 26.24 SQ. MILES



LEGEND

- EXISTING PAVED ROAD
- EXISTING GRAVEL ROAD
- RELOCATED ROAD
- ELECTRIC TRANSMISSION LINE
- RESERVOIR AT SPILLWAY CREST EL. 550.0

NOTES:

Elevations refer to Mean Sea Level Datum.

Contour interval equals ten feet.

Topography based on U.S.G.S. Map.

PLAN

SCALE: 1" = 500'

500 0 500 1000

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS. U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON MASS

DR. BY	TR. BY	CK. BY
W.T.N.	S.J.C.	J.W.D.

W. E. Hagle, Jr.
PROJECT ENGINEER

SUBMITTED BY
CHIEF, PLANN. & REP'TS BRANCH

APPROVED
CHIEF ENGINEERING DIV.

HOUSATONIC RIVER FLOOD CONTROL

SCOVILL DAM

RESERVOIR MAP

NAUGATUCK RIVER CONNECTICUT

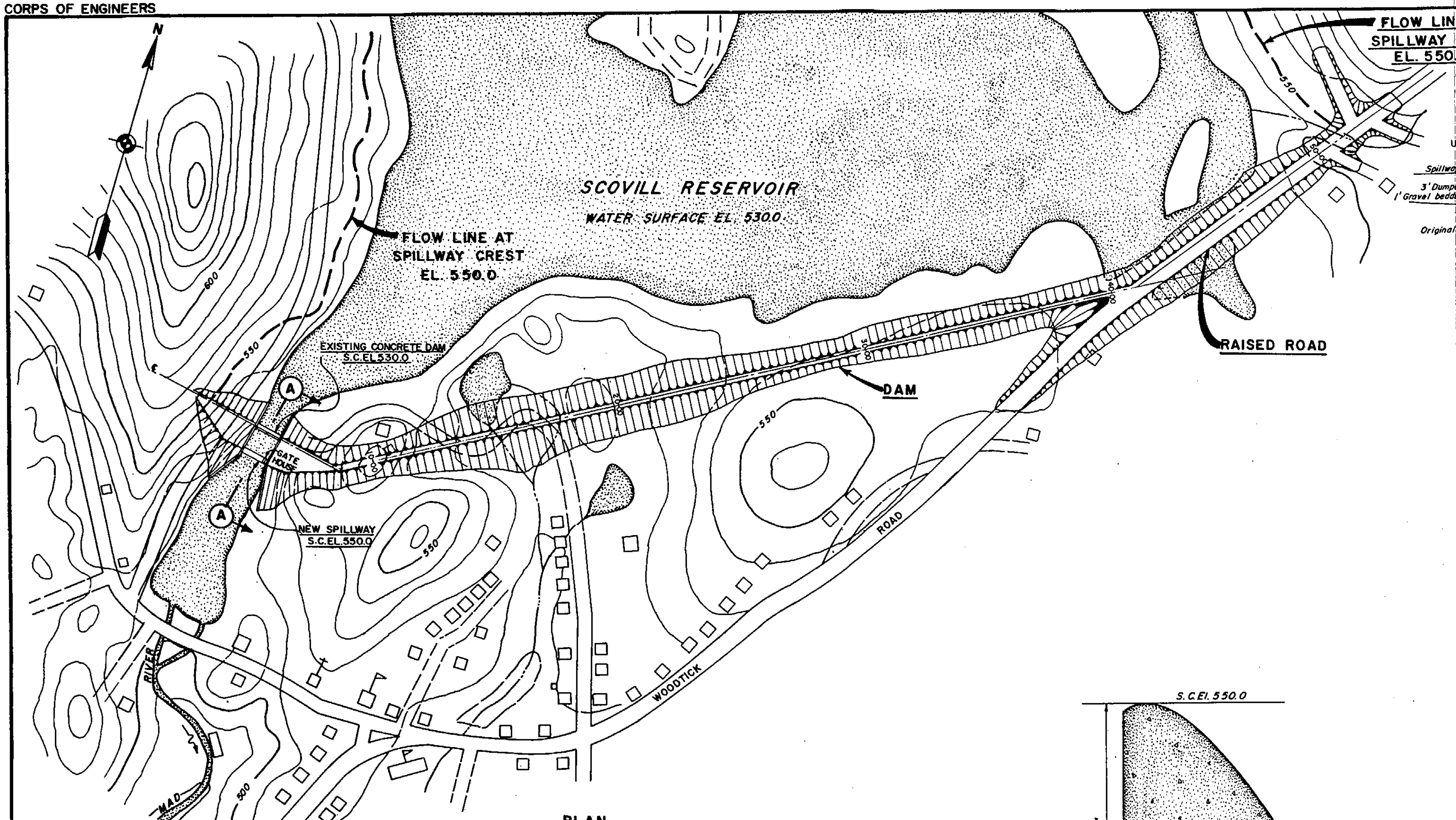
APPROVED Raymond A. Seifert
LT. COL. C.E. EXECUTIVE OFFICER

DATE JUNE 1958

SCALE: AS SHOWN

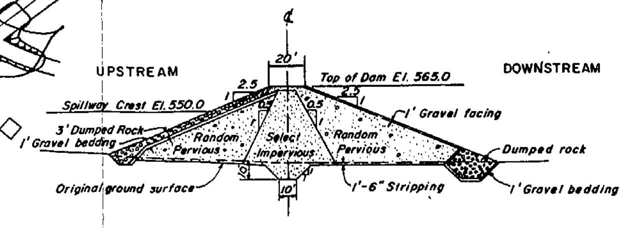
TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

DRAWING NUMBER
HC-1-1335
SHEET 1 OF 1



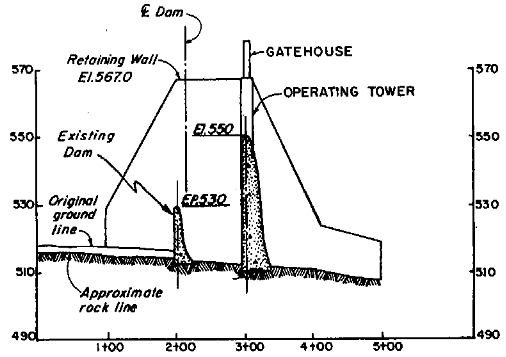
PLAN

SCALE: 1" = 200'



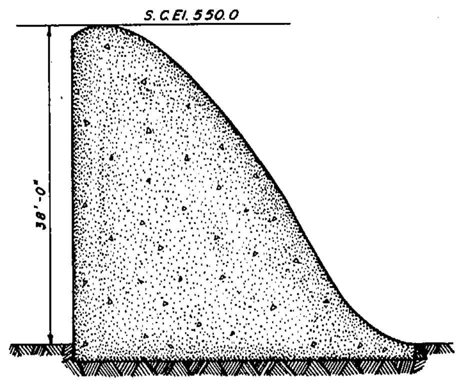
TYPICAL DAM & DIKE SECTION

SCALE: 1" = 40'



SECTION A-A

SCALE: HOR. 1" = 100' VERT. 1" = 20'

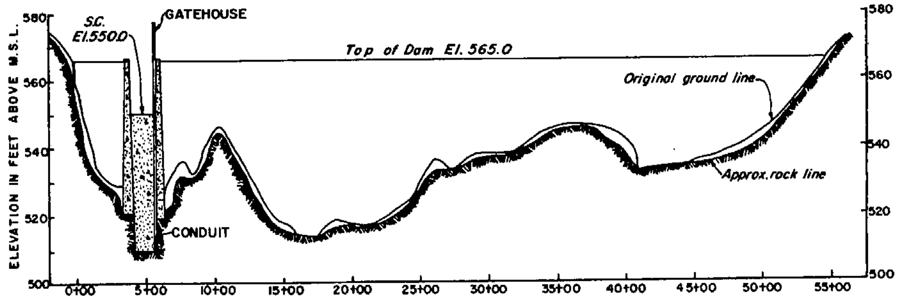


SECTION THRU SPILLWAY WEIR

SCALE: 1/8" = 1'-0"

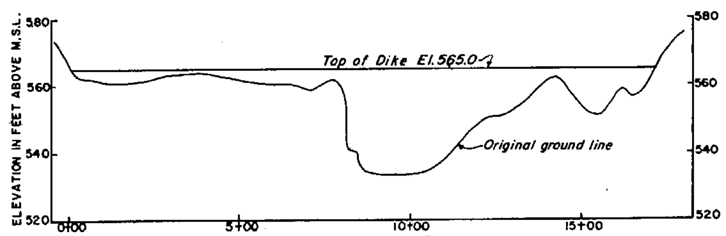
NOTES:

Topography based on U.S. Army Map Service map (1:25,000 - 1947).
Dam and dike profiles based on field survey.
Elevations refer to Mean Sea Level Datum.
Location of dike shown on Reservoir Map Plate No. E-3.
Contour interval equals ten feet.



PROFILE ALONG ℄ DAM

SCALE: HOR. 1" = 500' VERT. 1" = 20'



PROFILE ALONG ℄ DIKE

SCALE: HOR. 1" = 200' VERT. 1" = 20'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

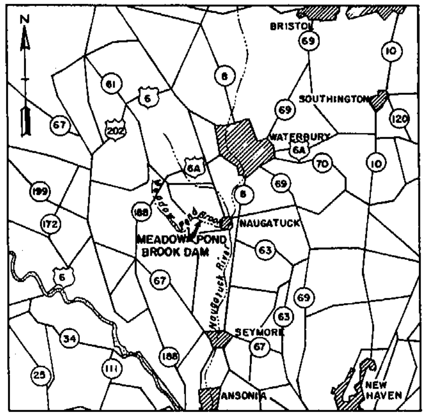
DR. BY W.T.N. | TR. BY A.J.H. | CK. BY J.W.D.

HOUSATONIC RIVER FLOOD CONTROL
SCOVILL DAM
GENERAL PLAN
NAUGATUCK RIVER CONNECTICUT

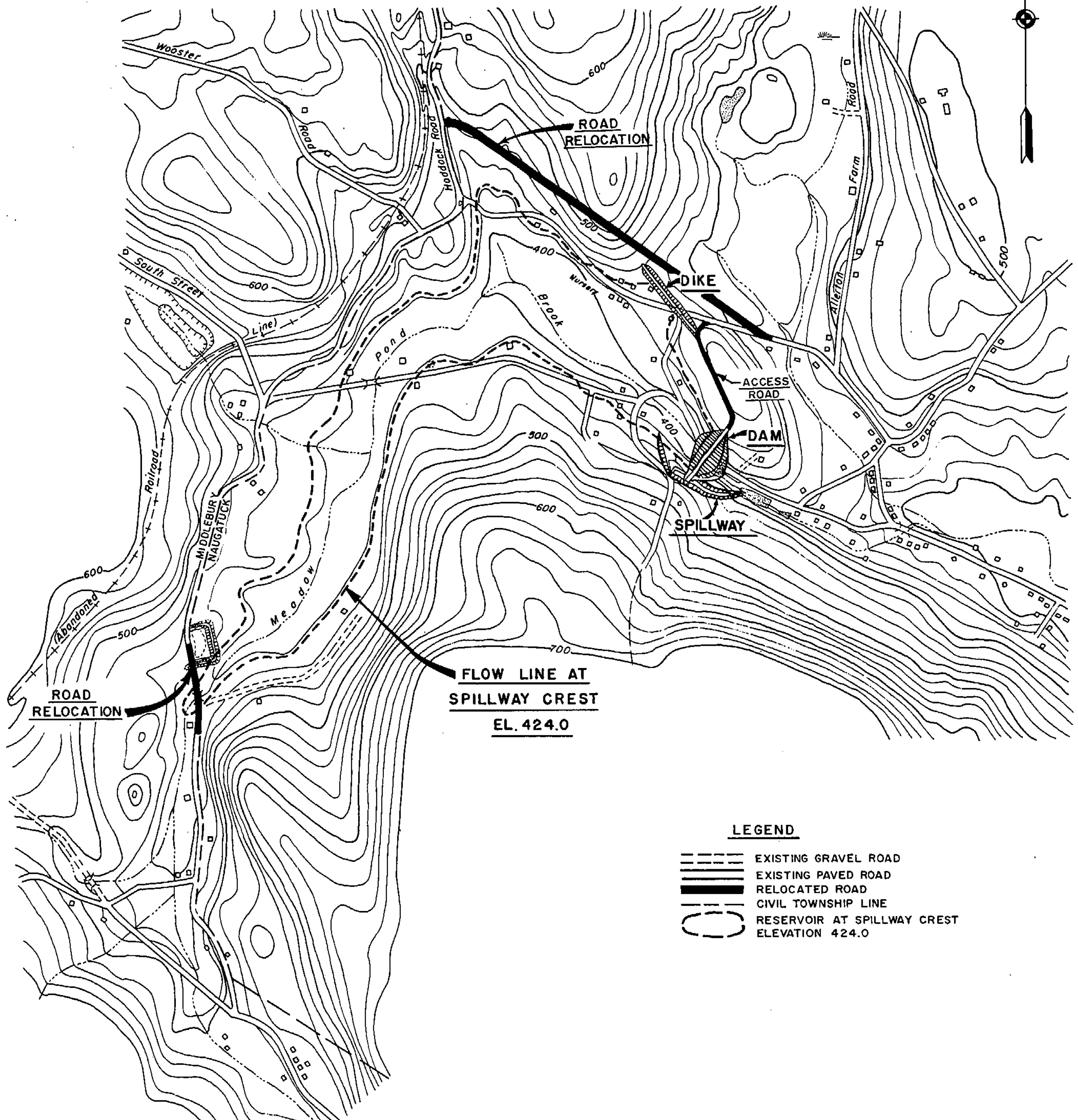
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANNING & REPORTS BRANCH
APPROVED
CHIEF, ENGINEERING DIV.
APPROVED
LT. COL. C.E. EXECUTIVE OFFICER
DATE JUNE 1958
SCALE: AS SHOWN

TO ACCOMPANY REPORT DATED: 30 JUNE 1958

DRAWING NUMBER HC-1-1336
SHEET 1 OF 1

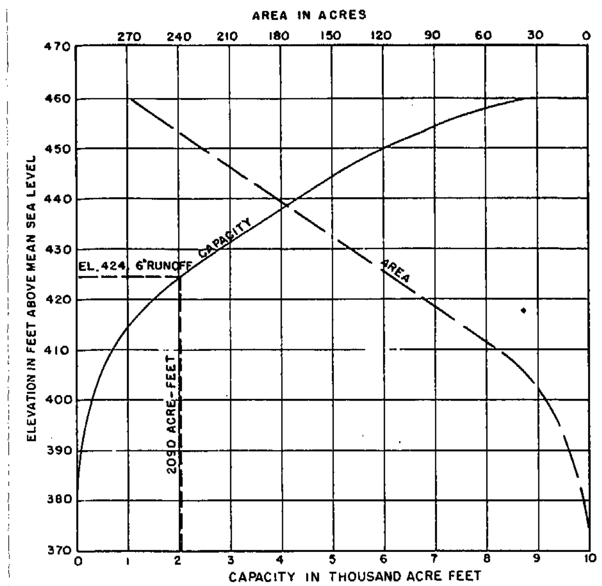


VICINITY MAP
SCALE IN MILES



PLAN
SCALE: 1"=500'

LEGEND
- EXISTING GRAVEL ROAD
- EXISTING PAVED ROAD
- RELOCATED ROAD
- CIVIL TOWNSHIP LINE
- RESERVOIR AT SPILLWAY CREST ELEVATION 424.0



AREA AND CAPACITY CURVES

(DAM) DRAINAGE AREA 6.54 SQ.MILES
(MOUTH) DRAINAGE AREA 8.62 SQ.MILES

NOTES:

Elevations refer to Mean Sea Level Datum.
Contour interval equals twenty feet.
Topography based on U.S.G.S. Map.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY W.T.N. | TR. BY P.W.G. | CK. BY J.W.D.

HOUSATONIC RIVER FLOOD CONTROL

MEADOW POND BROOK DAM

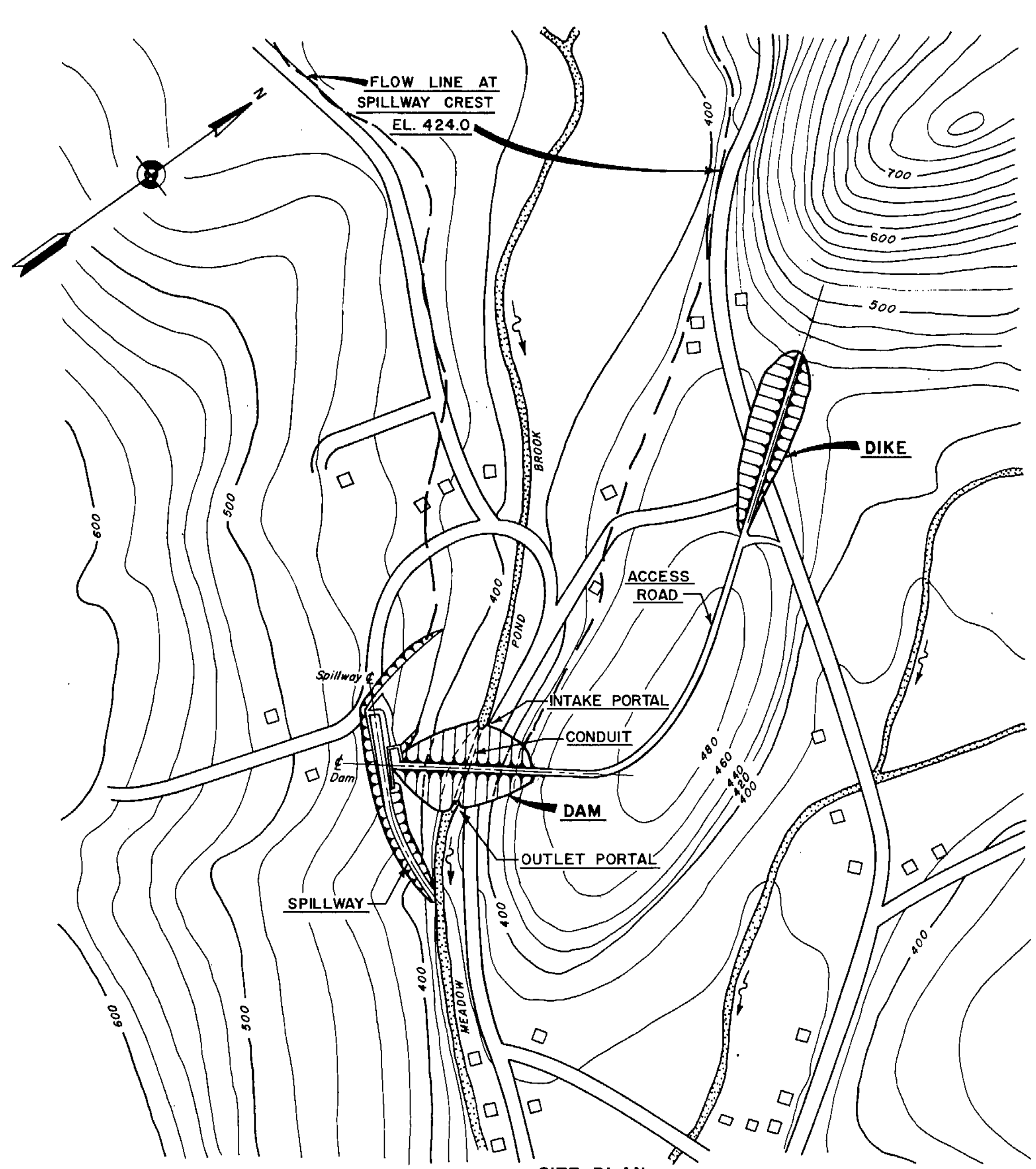
RESERVOIR MAP

NAUGATUCK RIVER CONNECTICUT

PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & MATS. BRANCH
APPROVED
CHIEF, ENGINEERING DIV.
APPROVED
LT. COL., C.E. EXECUTIVE OFFICER
DATE JUNE 1958

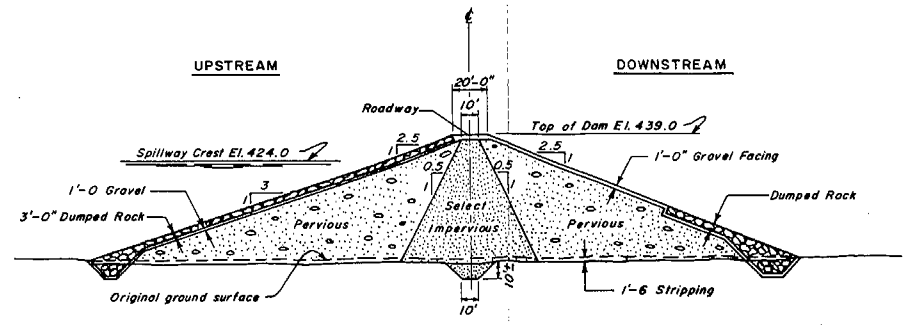
TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

SCALE AS NOTED
DRAWING NUMBER HC-1-1337
SHEET 1 OF 1



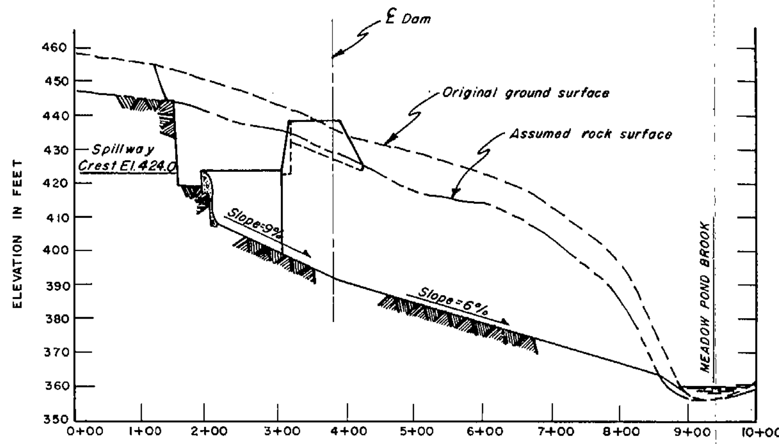
SITE PLAN

SCALE 1" = 200'



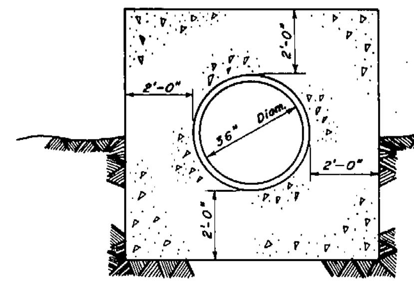
TYPICAL DAM & DIKE SECTION

SCALE: 1" = 40'



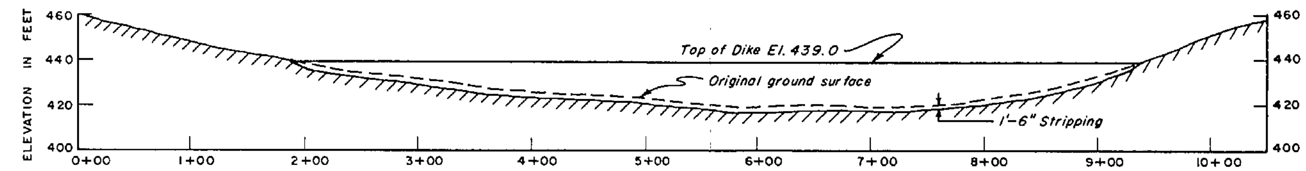
PROFILE ALONG ℄ SPILLWAY CHANNEL

SCALE: HOR. 1" = 100' VERT. 1" = 20'



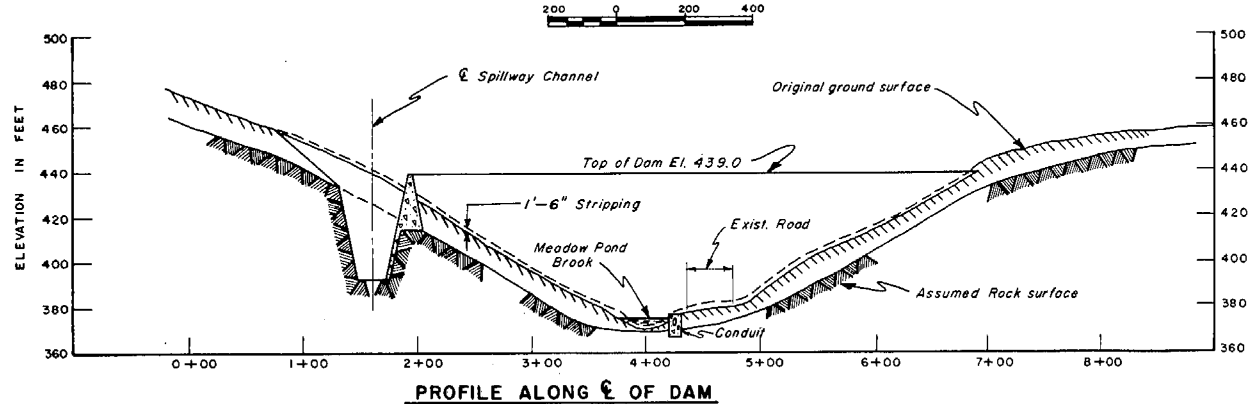
TYPICAL SECTION THROUGH CONDUIT

SCALE: 1/2" = 1'-0"



PROFILE ALONG ℄ DIKE

SCALE: HOR. 1" = 60' VERT. 1" = 30'



PROFILE ALONG ℄ OF DAM

SCALE: HOR. 1" = 60' VERT. 1" = 30'

NOTES:

Topography based on U.S. Army Map Service Map (1:25,000-1947).
Dam and Dike profiles based on field survey.
Elevations refer to Mean Sea Level Datum
Contour Interval twenty feet.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR BY W.T.N. | TR BY S.J.C. | CK BY J.W.D.

HOUSATONIC RIVER FLOOD CONTROL

MEADOW POND BROOK

GENERAL PLAN

NAUGATUCK RIVER CONNECTICUT

DATE JUNE 1958

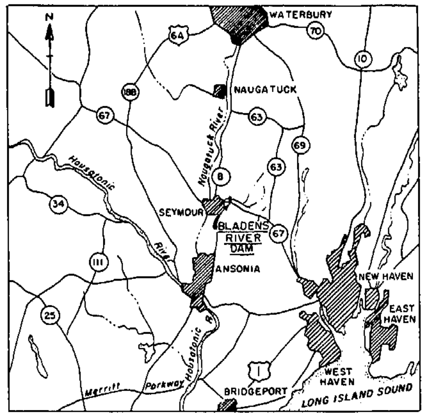
PROJECT ENGINEER
SUBMITTED BY
CHIEF PLAN. & MAT'LS BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
LT. COL. C.E. EXECUTIVE OFFICER

SCALE: AS SHOWN

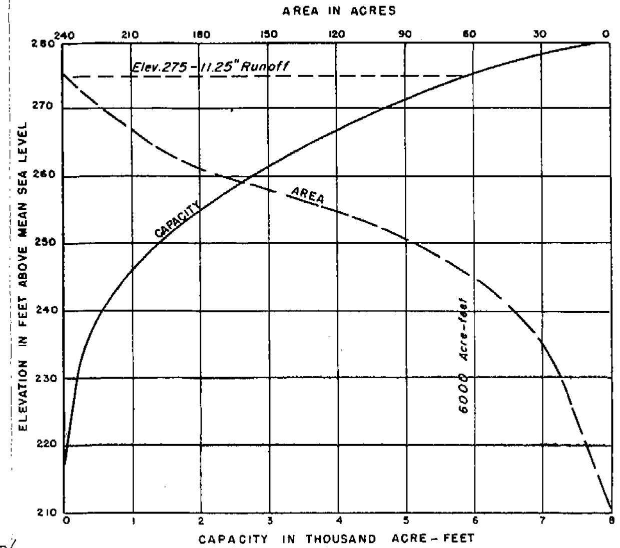
TO ACCOMPANY REPORT DATED: 30 JUNE 1958

DRAWING NUMBER HC-1-1338

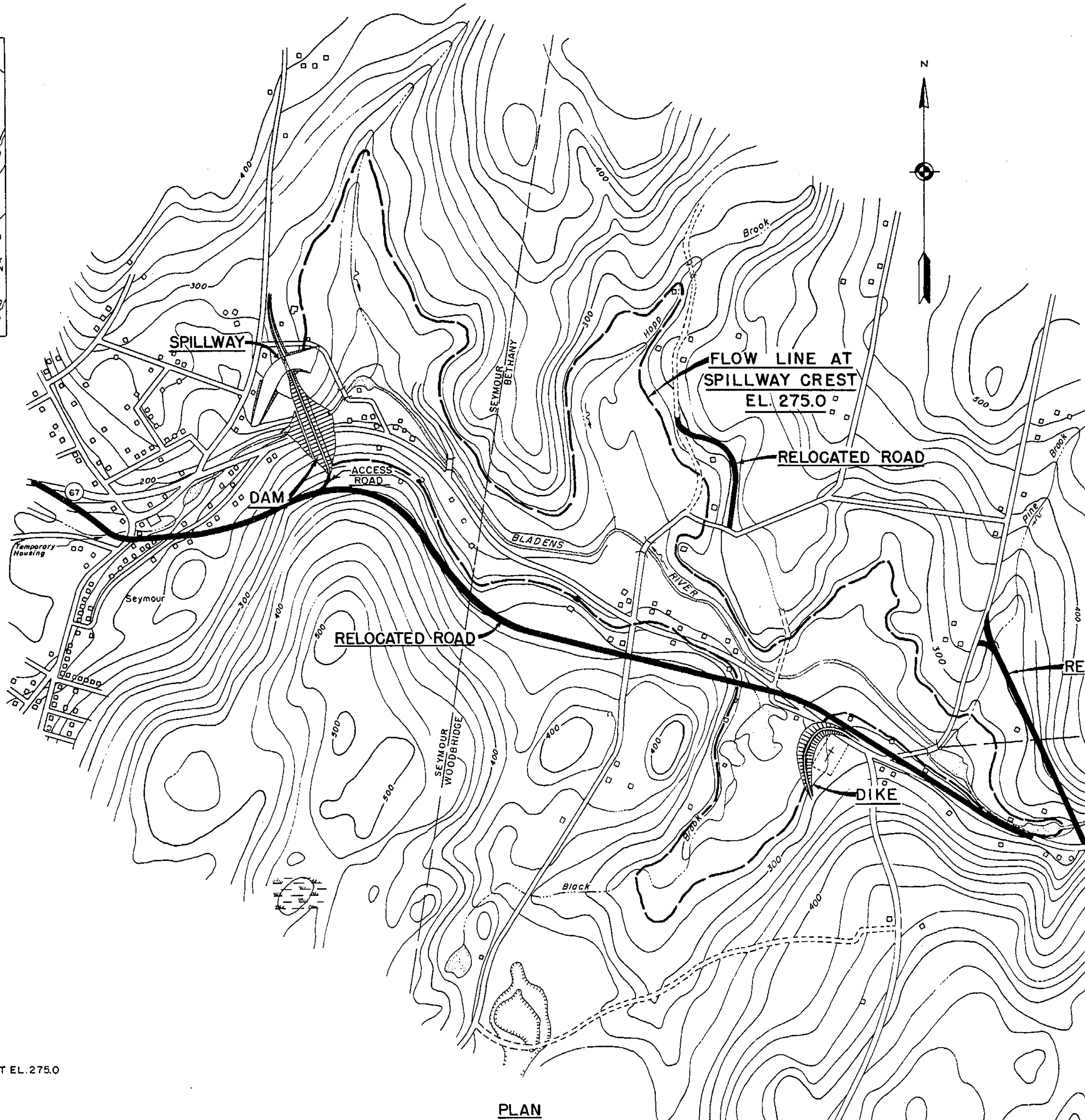
SHEET 1 OF 1



VICINITY MAP
SCALE IN MILES
5 0 5 10



AREA AND CAPACITY CURVES
(DAM) DRAINAGE AREA 9.97 SQ. MILES
(MOUTH) DRAINAGE AREA 10.80 SQ. MILES



LEGEND
EXISTING GRAVEL ROADS
SURFACED TOWN ROADS
RESERVOIR AT SPILLWAY CREST EL. 275.0
RELOCATED HIGHWAY
CIVIL TOWNSHIP LINE

PLAN
SCALE: 1" = 500'
500 0 500 1000

NOTES:
Elevations refer to Mean Sea Level Datum.
Contour Interval equals twenty feet.
Topography is based on U.S.G.S. Map.

REVISION	DATE	DESCRIPTION	BY

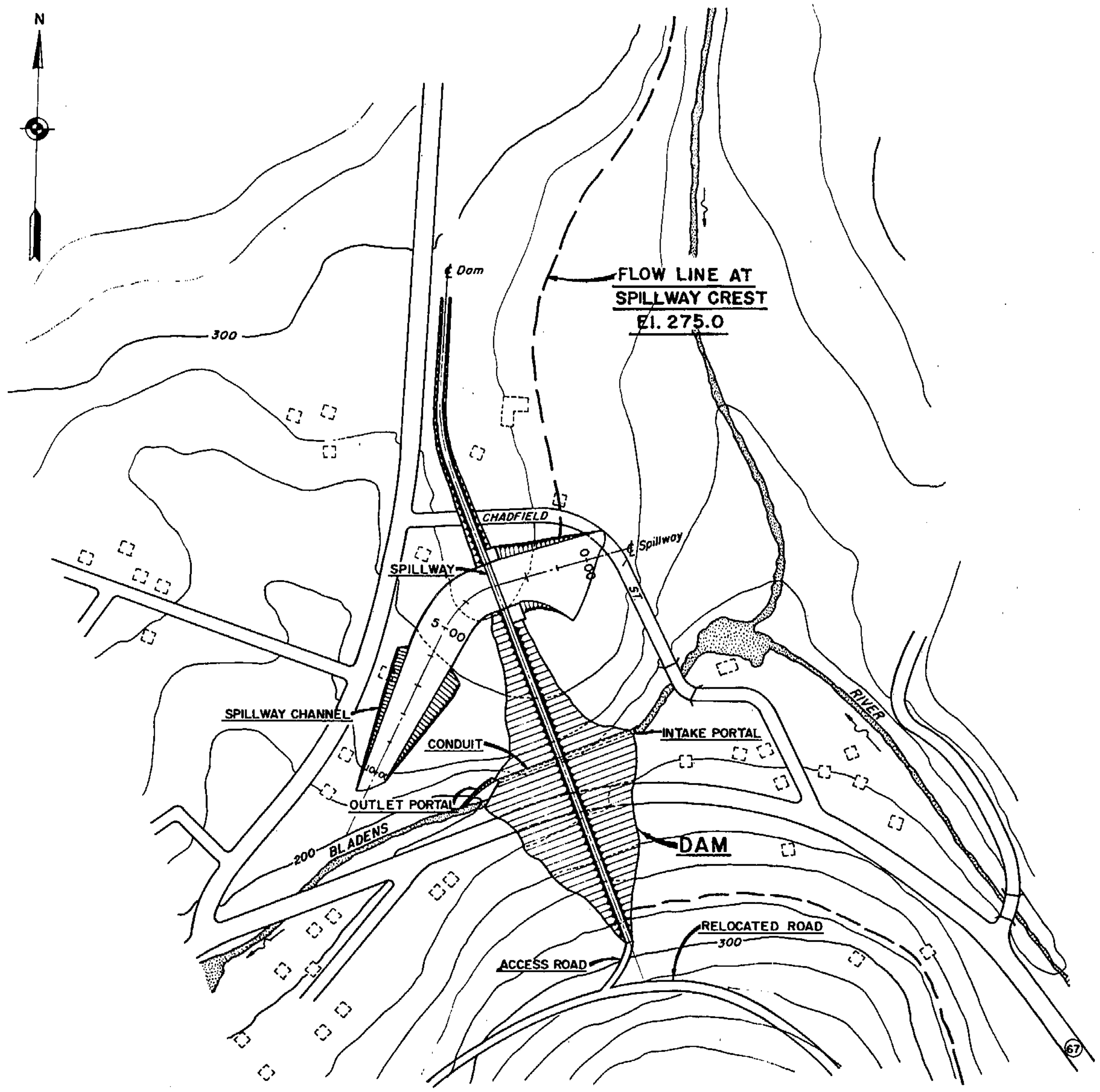
CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR BY W.T.N. TR BY P.W.G. CK BY J.W.O.

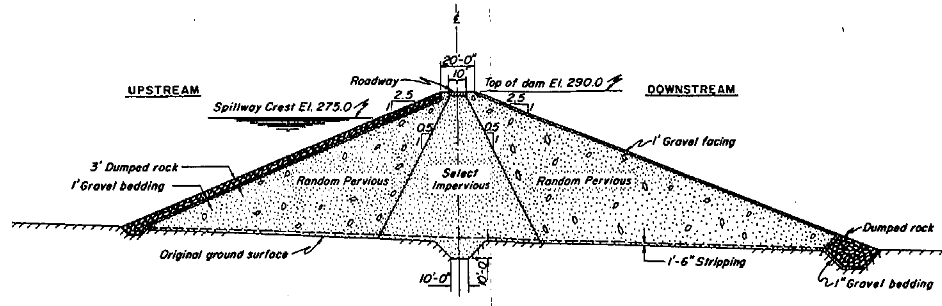
HOUSATONIC RIVER FLOOD CONTROL
BLADENS RIVER DAM
RESERVOIR MAP
NAUGATUCK RIVER CONNECTICUT

PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANNING BRANCH
APPROVED
CHIEF, ENGINEERING DIV.
APPROVED
LT. COL., C.E. EXECUTIVE OFFICER
DATE JUNE 1958

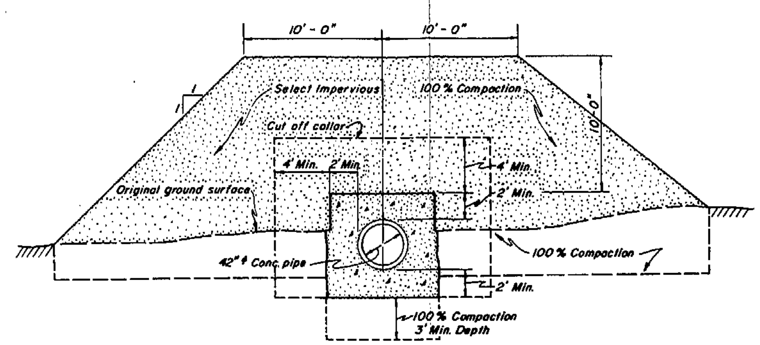
TO ACCOMPANY REPORT DATED: 30 JUNE 1958
SCALE AS SHOWN
DRAWING NUMBER HC-I-1339
SHEET 1 OF 1



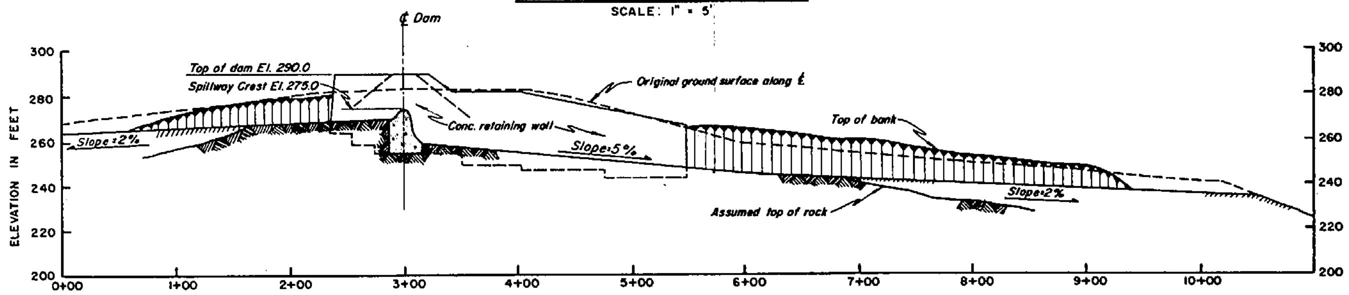
PLAN
SCALE: 1" = 200'



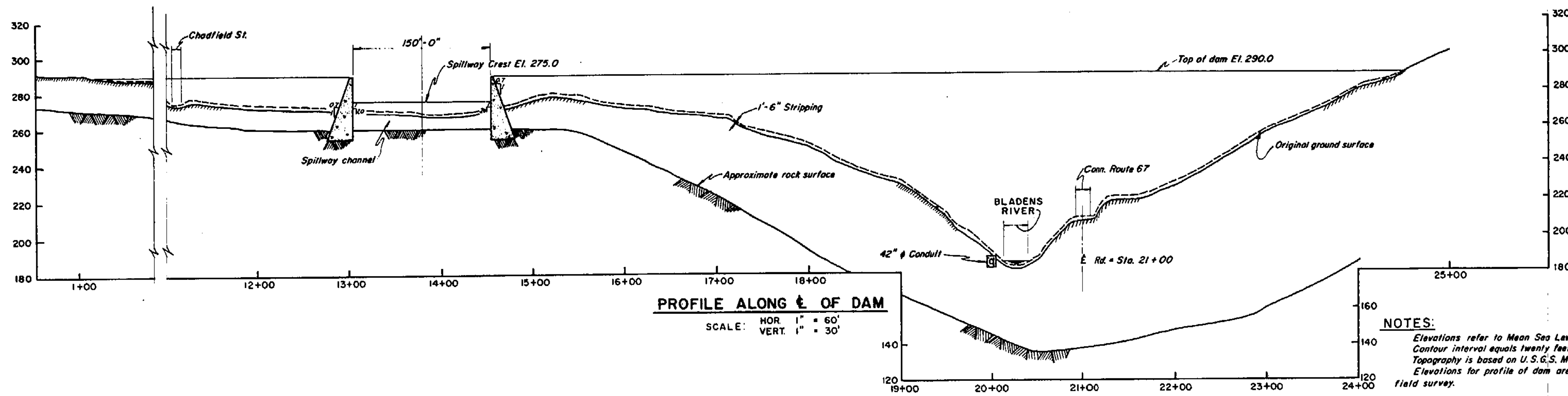
TYPICAL DAM SECTION
SCALE: 1" = 40'



SECTION THRU CONDUIT
SCALE: 1" = 5'



PROFILE ALONG ℄ SPILLWAY CHANNEL
SCALE: HOR. 1" = 60' VERT. 1" = 30'



PROFILE ALONG ℄ OF DAM
SCALE: HOR. 1" = 60' VERT. 1" = 30'

NOTES:
Elevations refer to Mean Sea Level Datum.
Contour interval equals twenty feet.
Topography is based on U.S.G.S. Map.
Elevations for profile of dam are based on field survey.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY R.J.D. | TR. BY F.L.C. | CK. BY J.W.D.

HOUSATONIC RIVER FLOOD CONTROL

BLADENS RIVER DAM

GENERAL PLAN

NAUGATUCK RIVER, CONNECTICUT

PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANNING & REPORTS BRANCH
APPROVED: CHIEF ENGINEERING DIV.
APPROVED: LT. COL. C.E. EXECUTIVE OFFICER

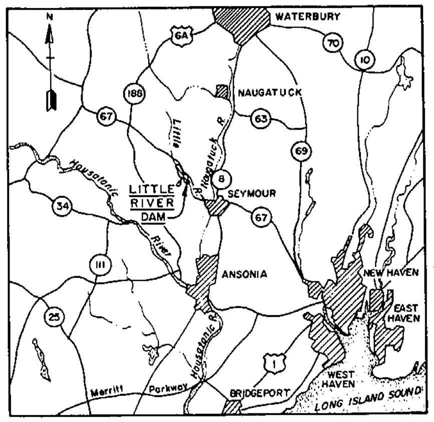
DATE JUNE 1958

SCALE: AS SHOWN

TO ACCOMPANY REPORT DATED: 30 JUNE 1958

DRAWING NUMBER HC-1-1340

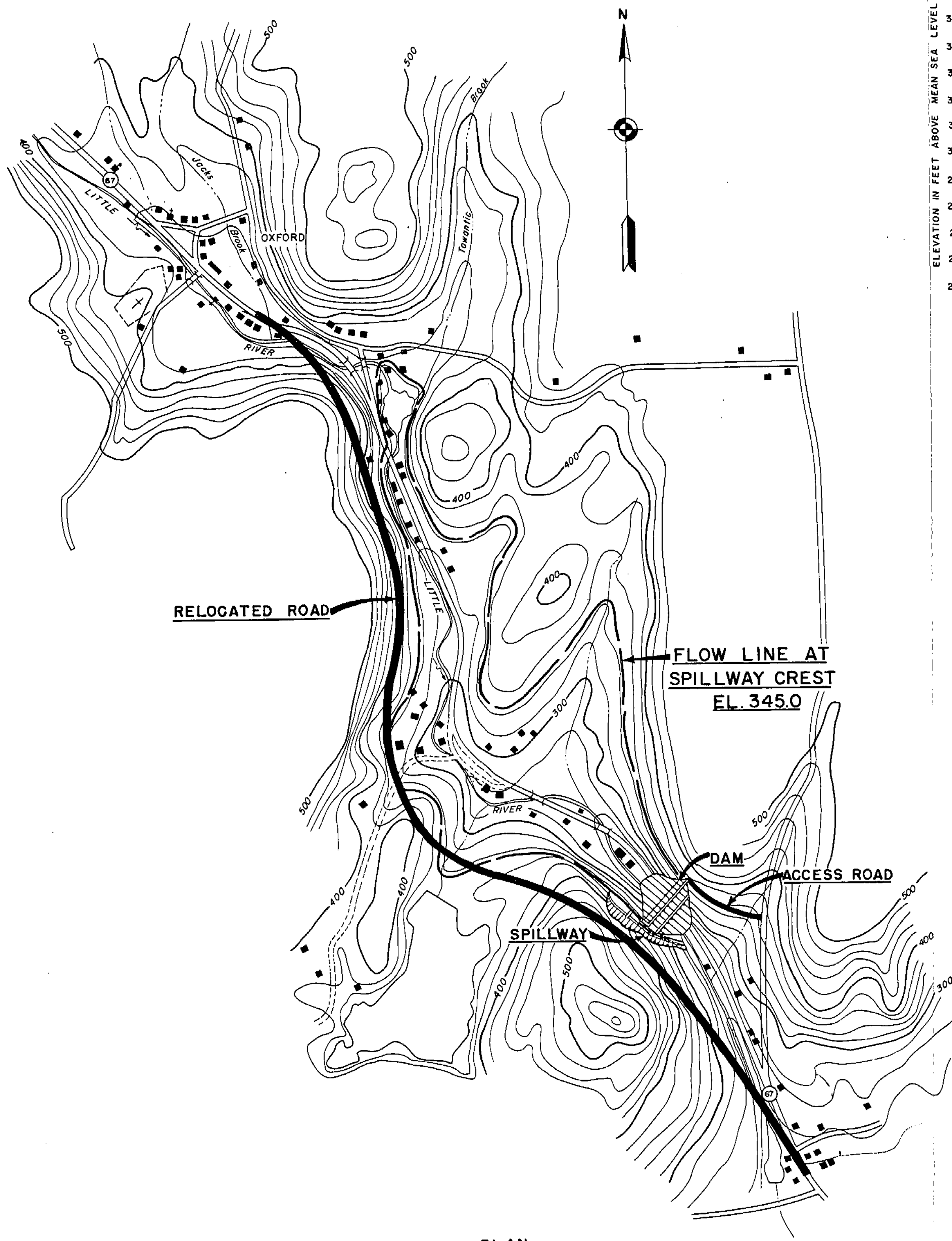
SHEET 1 OF 1



VICINITY MAP

SCALE IN MILES

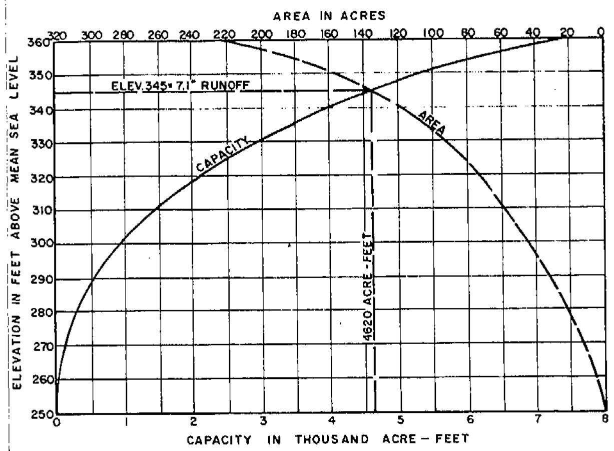
5 0 5 10



PLAN

SCALE: 1" = 500'

500' 0 500' 1000'



AREA AND CAPACITY CURVES

(DAM) DRAINAGE AREA 12.20 SQ. MILES
(MOUTH) DRAINAGE AREA 15.31 SQ. MILES

NOTES:

Elevations refer to Mean Sea Level Datum.
Contour interval equals twenty feet.
Topography is based on U.S.G.S. Map.

LEGEND

- EXISTING GRAVEL ROAD
- EXISTING PAVED ROAD
- RELOCATED ROAD
- RESERVOIR AT SPILLWAY CREST ELEVATION 345.0

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY	TR. BY	CK. BY
G.I.B.	A.J.H.	J.W.D.

HOUSATONIC RIVER FLOOD CONTROL

LITTLE RIVER DAM

RESERVOIR MAP

NAUGATUCK RIVER CONNECTICUT

PROJECT ENGINEER
SUBMITTED BY
CHIEF PLAN. & ... BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
LT. COL. C.E. EXECUTIVE OFFICER

DATE JUNE 1958

SCALE AS SHOWN

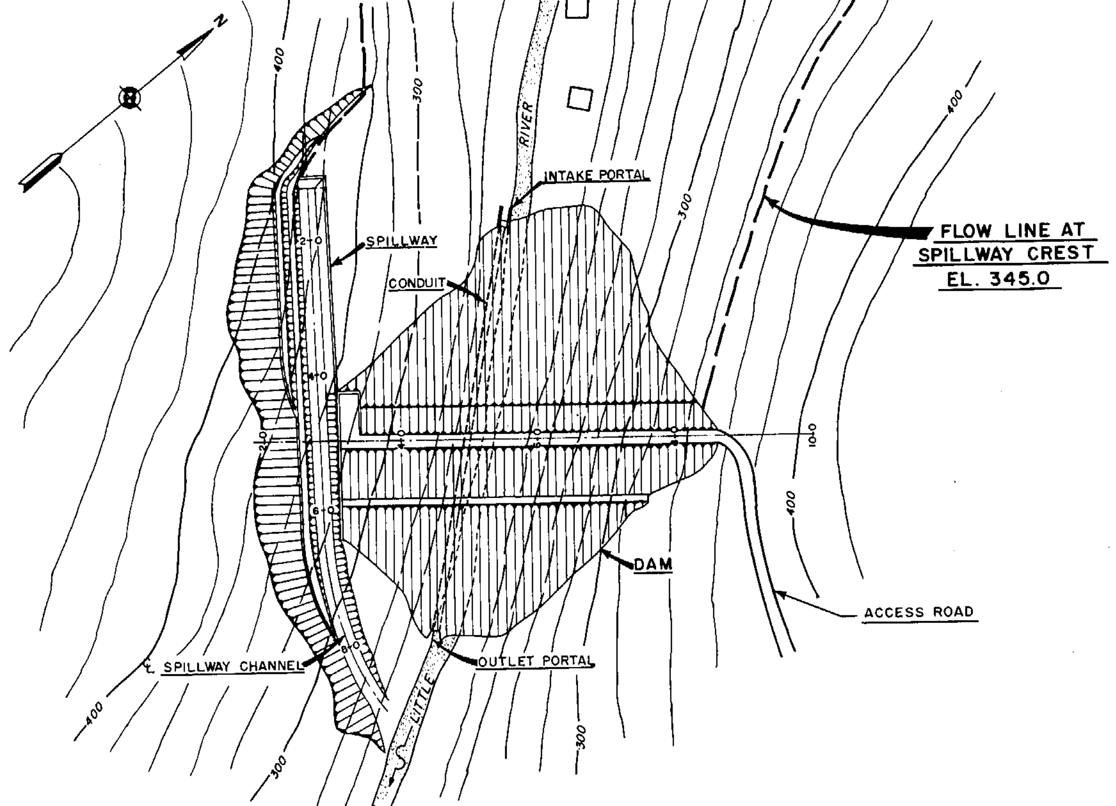
TO ACCOMPANY REPORT
DATED: 30 JUNE 1958

DRAWING NUMBER
HC-1-1341

SHEET 1 OF 1

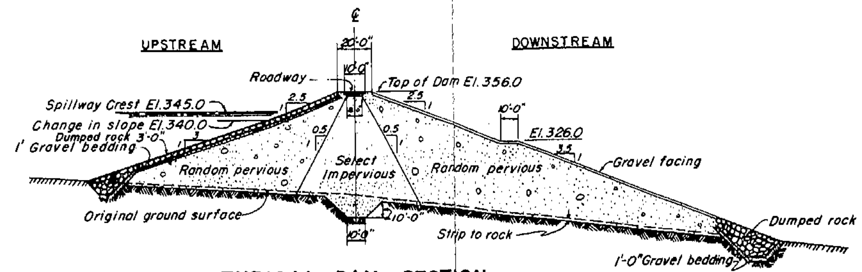
PLATE NO. E-9

CORPS OF ENGINEERS U. S. ARMY



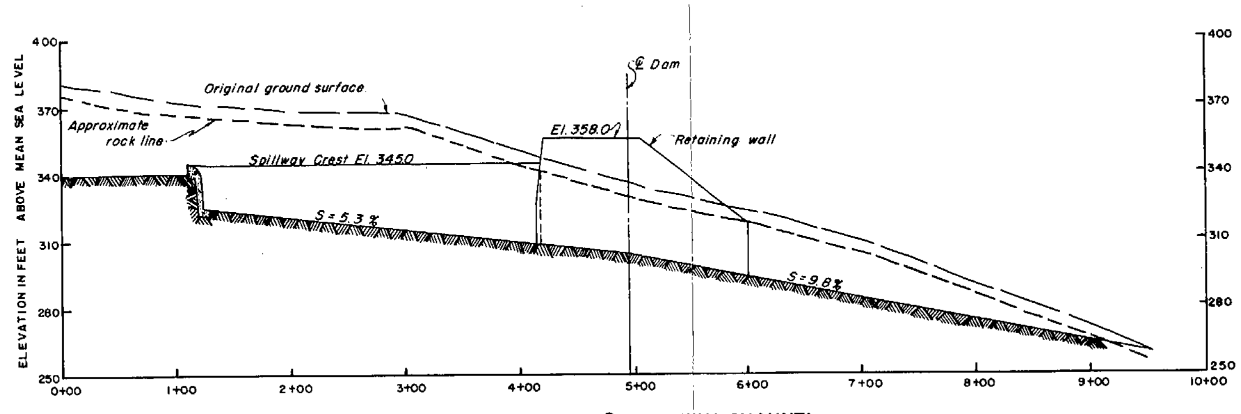
SITE PLAN

SCALE: 1" = 100'



TYPICAL DAM SECTION

SCALE: 1" = 40'

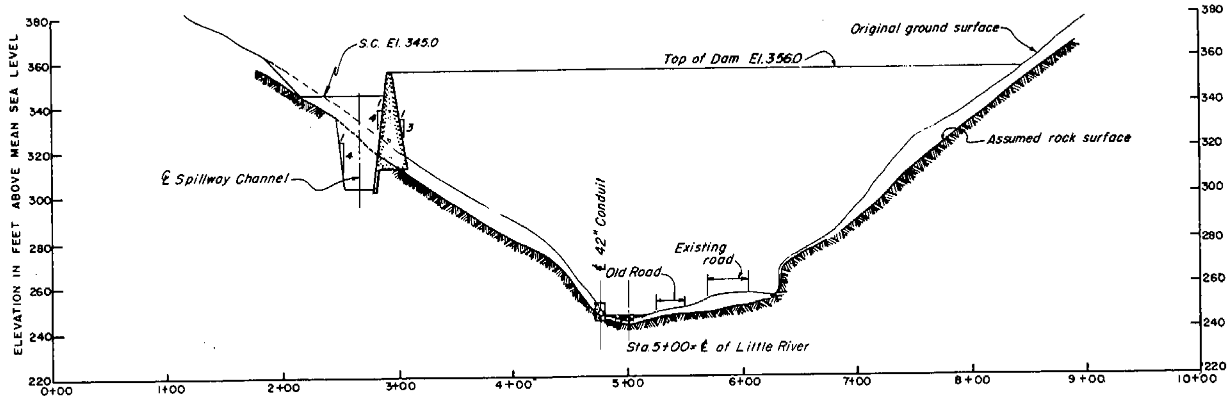


PROFILE ALONG ℄ SPILLWAY CHANNEL

SCALES: HOR. 1" = 60', VERT. 1" = 30'

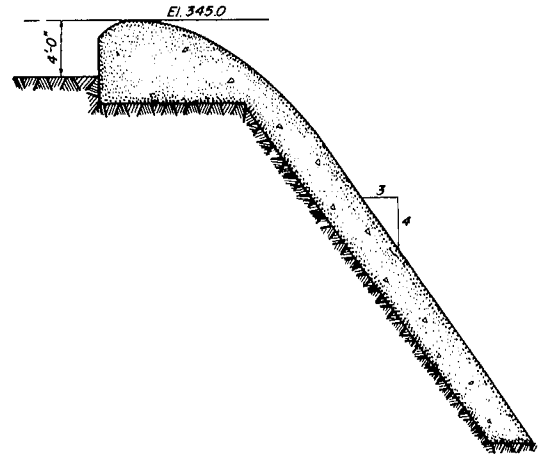
NOTES:

Topography based on U.S. Army Map Service map (1:25,000-1947).
Dam profile based on field survey.
Elevations refer to Mean Sea Level Datum.
Contour Interval 20 feet.



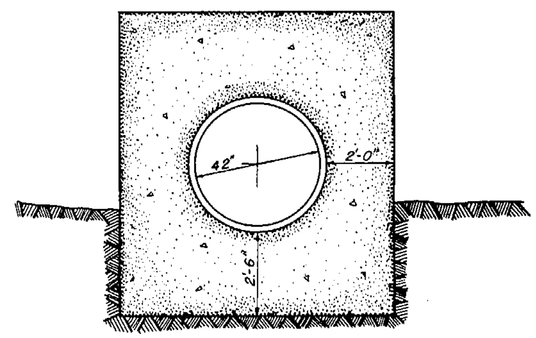
PROFILE ALONG ℄ DAM

SCALE: HOR. 1" = 60', VERT. 1" = 30'



SECTION THRU SPILLWAY WEIR

SCALE: 1" = 5'



TYPICAL CONDUIT SECTION

SCALE: 1/2" = 1'-0"

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

DR. BY G.I.B. | TR. BY A.J.H. | CK. BY J.W.D.

HOUSATONIC RIVER FLOOD CONTROL

LITTLE RIVER DAM

GENERAL PLAN

NAUGATUCK RIVER CONNECTICUT

PROJECT ENGINEER
SUBMITTED BY — CHIEF, PLANN. & M. BRANCH
APPROVED — CHIEF, ENGINEERING DIV.
APPROVED — LT. COL. C.E. EXECUTIVE OFFICER
DATE JUNE 1958
SCALE AS SHOWN

TO ACCOMPANY REPORT DATED: 30 JUNE 1958

DRAWING NUMBER HC-1-1342

SHEET 1 OF 1

PLATE NO. E-10

APPENDIX F

LETTERS OF COMMENT AND CONCURRENCE

APPENDIX F

LETTERS OF COMMENT AND CONCURRENCE

TABLE OF CONTENTS

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

500 Capitol Avenue
Hartford 6, Connecticut

February 7, 1957

Mr. H. J. Kropper
Chief, Engineering Division
Corps of Engineers, U. S. Army
New England Division
150 Causeway Street
Boston 14, Massachusetts

Dear Sir:

In response to your letter of October 25, 1956, we are sending our comments concerning the eight potential flood control dam sites on tributaries of the Naugatuck River as shown on the eight maps you sent to us soon after your letter.

Our comments on the various dam sites are as follows:

Northfield Brook:

The highway running through the center of this dam site close to Northfield Brook is Federal-aid Secondary Route 223. Within the past month a project was let to contract which involves the reconstruction of this highway throughout most of the length within the reservoir, as shown on the attached sketch. This Project ((S-74 (1))) is on Federal-aid Secondary Route 223 from a point about 0.4 of a mile north of the Litchfield-Thomaston Town Line, southeast to a point about 1.4 miles southeast of the Town Line. This project is for the grading, draining and paving of 1.8 miles of two-lane high type pavement and the construction of one structure and extensions of two other structures over Northfield Brook in the Town of Thomaston. The total estimated cost of this project is estimated at $360,000. If this proposed dam were constructed as shown on your map, the project described above would be inundated.

Branch Brook:

Two Federal-aid Secondary Routes would be affected by the construction of the Branch Brook dam; namely, Federal-aid Secondary Routes 214 (Conn. 109) and 134 (U.S. 6). We have discussed the relocations as shown on your map with the State Highway Department. It is their opinion and ours that if relocation of these routes in this area were made necessary by the construction of the dam, the new routing would preferably be other than as shown on your map, particularly with regard to Federal-aid Secondary Route 134.

Branch Brook (continued)

Within the past year, an Emergency Relief Bridge Replacement Project (Project ER-4) was constructed at the point where Federal-aid Secondary Route 134 crosses Branch Brook at a total cost of approximately $86,000. This bridge would be inundated if the dam were constructed as shown on your map.

Hancock Brook:

There are no Federal-aid routes affected by the Hancock Brook Dam as shown on your map.

Scovill Dam:

Connecticut Route 69 which lies along the west boundary of your map marked Plate D is Federal-aid Secondary Route 126. This route would be affected by the proposed dam in a very minor way at the point where it crosses Mad River. Most likely whatever adjustment that might be required on this route could be made with maintenance forces. However, the effects of the dam would cut off other roads running in generally the same direction as this secondary route. The increased increments of traffic might require improvement of the Federal-aid Route to a higher standard. This could be determined after some study by the State Highway Department.

Hop Brook Dam:

Federal-aid Secondary Route 136 (Conn. 63) runs through the middle of the reservoir as shown in your map marked Plate XI. A rather considerable relocation of this Federal-aid Route would be required. We feel that a more satisfactory relocation could be provided and would suggest that the subject be studied by the State Highway Department.

Also affected by this proposed dam is proposed Federal-aid Interstate Highway #84 which, insofar as we can determine at this time, will pass through what is shown on your map as the most northerly reaches of the reservoir. Interstate Route 84 should cross Federal-aid Secondary Route 136 about 500 to 1,000 feet north of Country Club Road, or thereabouts.

Since the depth of water within a reservoir just north of Country Club Road is very shallow, the location of the route may not be seriously affected. However, it is planned to provide a connection to Federal-aid Secondary Route 136 at this point and this would not be possible if the dam were constructed.

Meadow Pond Brook:

There are no Federal-aid Routes affected by this dam.

Little River Dam:

The route passing through the center of the dam and the reservoir is Federal-aid Secondary Route 122, and, as shown on your map, would have to relocated. Traffic service would not be reduced by the proposed relocation.

Bladens River Dam:

Connecticut Route 67, within the limits of your map marked Plate XVII, is also Federal-aid Secondary Route 122. As shown on your map, this highway would need to be relocated.

....

The above comments are rather general and perhaps do not entirely satisfy your needs. We would recommend that if more detailed information is required a meeting be arranged between your field representative, some one from the State Highway Department and engineers from our office to discuss whatever additional information you may desire. One question that arose when we discussed the effect of the Naugatuck River projects on Connecticut highways with representatives of the State Highway Department concerned the relocations that you propose as shown on your maps. In several cases, both our office and the State Highway Department feel that these relocations could be improved to provide better traffic service. Another question we have pertains to the priority of these projects.

We shall be pleased to attempt to gather any additional specific information which would be of help in your study, if you request. However, as we suggest above, we feel that the most beneficial results would be obtained through a meeting of our respective engineers with those of the State Highway Department.

We regret the delay in sending you our comments.

Very truly yours,

Leo Grossman
District Engineer

EXHIBIT 1-3

PRELIMINARY EVALUATION REPORT ON VECTOR PROBLEMS RELATED TO PROPOSED HOUSATONIC RIVER FLOOD CONTROL PROJECTS IN CONNECTICUT

Inclosure to letter dated January 30, 1957 from Department of Health, Education, and Welfare, Public Health Service, Region II, New York, N. Y.

EXHIBIT 2-1

VECTOR-BORNE DISEASE AND VECTOR PROBLEMS

Malaria

Malaria is not known to be of public health importance in Connecticut. The malaria mosquito (Anopheles quadrimaculatus) occurs throughout the State, but normally it is not very abundant. This species frequently breeds in impoundments that contain vegetation or flotage.

Encephalitis

No human cases of Eastern equine encephalitis have ever been confirmed in the State. Horse cases have been uncommon in Connecticut, but outbreaks among captive pheasants occurred in 1938, 1951, 1953, 1955, and 1956.

It is noteworthy that a severe outbreak of Eastern equine encephalitis occurred in nearby Massachusetts during 1956. This outbreak involved 16 human cases (mostly children), 41 horse cases, and 12 pheasant farms.

The mosquito Culiseta melanura is strongly suspected as transmitter of the encephalitis virus to the pheasant. The larvae of this species are usually found in shaded small pools of acid water (bogs).

At present, the transmitter of the Eastern equine encephalitis virus to man and horses is unknown, but salt-marsh mosquitoes

(*Aedes sollicitans*) and floodwater mosquitoes (*Aedes vexans*) are strongly suspect.

Aedes Mosquitoes

The principal insects of public health importance in the reservoir areas are *Aedes* mosquitoes. These insects, which cause severe annoyance to humans and domestic animals, include the following groups: (1) woodland species (e.g. *Aedes intrudens*) that develop in temporary grassy or leafy pools during early spring, and (2) floodwater mosquitoes, especially *Aedes vexans*, which breed in temporary pools throughout the spring and summer.

ANTICIPATED EFFECTS OF THE PROJECTS UPON VECTOR PRODUCTION

The overall effects of the projects should be beneficial from a mosquito control standpoint since many swampy areas would be inundated and flooding in downstream areas would be diminished. The latter condition would result in a decrease in production of the highly annoying floodwater mosquitoes.

Mosquito problems that might be created as a result of the projects include the following: (1) malaria mosquito producing areas in quiet, shallow water containing vegetation and/or flotage, and (2) floodwater mosquito producing areas during high flood crests in the spring or summer.

RECOMMENDATIONS

In order to avoid the creation of vector mosquito problems, the following basic principles should be adhered to by the Corps of Engineers in the development of more detailed plans for the design, construction, and operation of the projects.

1. Clear the reservoir sites of trees and brush. (The reservoir clearing plans should have the approval of the Connecticut State Department of Health and the Public Health Service).

2. Locate borrow pits, if possible, where they will be permanently inundated.

3. Provide drainage ditches for the elimination of seepage areas and similar types of ponded water.

4. Remove flotage, secondary growth, and/or aquatic plants as necessary after impoundment.

5. Provide in the maintenance program for regular and frequent field surveys to determine the amount of mosquito breeding.

6. Provide for chemical measures to control excessive production of mosquitoes, especially during periods of high flood crests.

It is further recommended that the Corps of Engineers keep the Connecticut State Department of Health and the Public Health Service currently advised regarding project construction schedules so that guidance, consultation, and specific recommendations may be provided with regard to vector problems associated with these projects.

Bureau of Sanitary Engineering
Connecticut State Department of Health
Hartford, Connecticut

Logan Field Station Section
Technology Branch
Communicable Disease Center
U.S. Public Health Service
Atlanta, Georgia

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
OFFICE OF REGIONAL DIRECTOR
BLAKE BUILDING
BOSTON 11, MASSACHUSETTS

REPLY REFER TO:

REGION 5

NEW ENGLAND STATES
NEW YORK
PENNSYLVANIA
NEW JERSEY
DELAWARE
WEST VIRGINIA

May 22, 1958

Division Engineer
New England Division
U. S. Corps of Engineers
150 Causeway Street
Boston 14, Massachusetts

Dear Sir:

Reference is made to your letter of April 2, 1958 in which you requested comments from this office relative to the proposed Black Rock site, Branch Brook, Naugatuck River Basin, Connecticut, as well as additional comments on the Northfield Brook, Hancock Brook, Branch Brook and Hop Brook sites, proposed flood control projects in Connecticut commented on by this office December 14, 1956.

Black Rock

The Black Rock dam site, located at river mile 1.8 on Branch Brook, is proposed as alternate for and situated 1.0 mile upstream from the Branch Brook dam site. At spillway crest Black Rock dam would inundate approximately 200 acres of which about 150 acres are in Black Rock State Park. The reservoir site, comprised almost entirely of forest, provides good habitat for grouse, fair habitat for squirrels, and habitat of low value for rabbits. Because approximately 75 per cent of the reservoir site is in Black Rock State Park and is not open to hunting, hunting pressure over the entire proposed reservoir area is necessarily very low. By providing sanctuary, however, the Park produces wildlife, some of which helps to repopulate adjacent lands open to hunting. Completion of the project would result in minor losses to wildlife through flooding of habitat.

Branch Brook is stocked with trout annually by the State Board of Fisheries and Game and receives moderate fishing pressure from local anglers as well as visitors to the State Park from elsewhere in the State. Completion of the project would result in minor losses to the reservoir area fisheries resource.

Northfield Brook, Hancock Brook, Branch Brook and Hop Brook

Comments in the report submitted December 14, 1956 relative to the effects these four projects would have on the fish and wildlife resources in the project areas are still valid. The overall effects of the four projects are not severely adverse and opportunities for realistic mitigation appear limited. This office, however, will appreciate the opportunity to determine whether further studies would be necessary after the projects are authorized.

Very truly yours,

E W Bailey

E. W. Bailey
Acting Regional Director

REGION 5

NEW ENGLAND STATES
NEW YORK
PENNSYLVANIA
NEW JERSEY
DELAWARE
WEST VIRGINIA

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

OFFICE OF REGIONAL DIRECTOR
BLAKE BUILDING
BOSTON 11, MASSACHUSETTS

December 14, 1956

Division Engineer
New England Division
Corps of Engineers
150 Causeway Street
Boston 14, Mass.

Dear Sir:

Reference is made to your letter of October 24, 1956 in which you requested comments from this office in relation to eight potential reservoirs in Connecticut. The eight reservoirs under consideration are Northfield Brook, Branch Brook, Hancock Brook, Scovill, Hop Brook, Meadow Pond Brook, Little River, and Bladens River.

The information concerning these reservoirs in the attachment is of a preliminary nature and is based on a cursory field examination of the proposed reservoir sites. The information is not regarded as adequate to fulfill our obligations under the Coordination Act (60 Stat. 1080).

This office welcomes the opportunity to comment on these projects during preliminary stages of planning. Detailed reports will be prepared when required by your office.

Very truly yours,

D R Gascoyne

D. R. Gascoyne
Regional Director

EXHIBIT 4-1

Preliminary Statement of Relation to Fish and Wildlife Resources to Proposed Reservoir Developments at Northfield Brook, Branch Brook, Hancock Brook, Scovill, Hop Brook, Meadow Pond Brook, Little River, Bladens River, all in Connecticut

Northfield Brook

This small reservoir site of 80 acres to be located on Northfield Brook near Thomaston, Connecticut, differs from most of the reservoirs under consideration in that it is about 70% woodland. Squirrels and cottontail rabbits are the most common game animals present on the reservoir site. A few grouse are also present. In all probability a small to moderate loss would accrue to wildlife, through the assumed flooding and killing of woody vegetation in the lower portion of the reservoir. It is desired that lands and easements should provide for public access for hunting.

Northfield Brook is stocked annually with trout by the State and receives low to moderate fishing pressure from local anglers. Approximately 1.2 miles of Northfield Brook within the reservoir site would be subject to periodic and temporary flooding. While the stream fishery would not be entirely destroyed, there is little doubt but what the stream fishery in the lower portion of the reservoir would be reduced in value. The public should have unrestricted use of Northfield Brook for fishing purposes. Consideration should be given to the establishment of a permanent pool directly behind the dam. A pool at elevation 490 feet would pond approximately 3.6 acres of which .8 acre would be 10 to 20 feet deep. While not large, such a pool would help relieve a shortage of water open to public fishing.

Branch Brook

Branch Brook Reservoir would be located near Thomaston, Connecticut. Ponding 290 acres at spillway crest, it would include wildlife habitat valuable at present to cottontail rabbits and squirrels. Grouse would also be affected, though to a small degree. Because of the presence of a heavily used State Park and numerous private homes within the reservoir flow line, hunting is almost non-existent. Habitat utilized by rabbits would be most affected if the reservoir were constructed. In planning for post-project development, it would be desirable that lands and easements provide for public access for hunting.

Branch Brook is stocked with trout annually and receives moderate fishing pressure from local anglers as well as nonlocal visitors. If the project is constructed, provision should be made for public access to all of Branch Brook within the reservoir area for fishing.

Hancock Brook

Located in Plymouth and near Waterbury, Connecticut, the site of Hancock Brook Reservoir encompasses 350 acres of good small game habitat. Habitat for cottontail rabbits is excellent, while habitat for pheasant is of moderate quality. Lesser amounts of habitat are suitable for squirrel, woodcock and waterfowl. Favorable conditions are also present for small numbers of mink and muskrat. Considerable hunting pressure exists on the area despite extensive posting along Todd Hollow Brook. Although the construction of Hancock Brook Reservoir would probably bring about the loss of considerable brush habitat, the value of the project area for wildlife would not be appreciably decreased provided lands and easements are made available to the public for hunting purposes.

Hancock Brook is also an important trout stream locally and is stocked annually by the State. Because the basin of this proposed reservoir is long and flat, a high proportion of the stream could be inundated rather frequently thus materially lowering the value of the stream as trout habitat. To counterbalance this loss, it is suggested that consideration be given to the establishment of a sub-impoundment on the small tributary that flows into Meyers Pond. Water ponded to the reservoir flow line behind the proposed raised section of road would provide approximately two acres of water probably suitable for trout.

Scovill Dam

The proposed Scovill flood control reservoir would be located atop Scovill Reservoir, a body of water on the Mad River owned by the Scovill Manufacturing Company, Waterbury, Connecticut. Of the 240 acres within the flow line of the proposed reservoir, approximately 100 acres would be land not now inundated. Rabbits and squirrels are the game animals common to the project lands with an occasional pheasant utilizing the area. The extent of usage of the reservoir by waterfowl is not known though it could be moderate to high during migration. Flooding the additional acreage between the present pool level and the proposed flow line is not expected to cause more than minor damage to wildlife. At present what hunting takes place is done by employees of the Scovill Manufacturing Company. If the reservoir is constructed, it would be desirable that post-development planning include public access to the project lands for hunting purposes.

On the present Scovill Reservoir, the Company maintains boat facilities for its employees. The reservoir (approximately 140 acres) is said to receive heavy fishing pressure and supplies good fishing primarily for warm water fish. The Mad River is a trout stream and is stocked annually by the State. It would be desirable that the segments of Mad River and other tributaries between the present pool level and the flood control reservoir flow line be accessible to the public for fishing purposes.

Hop Brook

Hop Brook Reservoir, which would be located in the towns of Naugatuck, Waterbury, and Middlebury, would encompass 320 acres of high quality small game habitat. The reservoir acreage is made up of habitat excellent for rabbits, good for squirrels and pheasants, and fair for grouse. Despite the existence of some posting against access, the reservoir area as a whole receives moderate hunting pressure. Losses to wildlife are not expected to be severe provided lands and easements are made available to the public for hunting purposes. An excellent opportunity exists for the establishing of a subimpoundment for waterfowl on Wooster Brook. A pond of approximately 10 acres and controlled by a drop inlet structure could be impounded by the proposed raised section of State Highway 63.

Hop Brook is considered to be an important trout stream locally and is stocked annually by the State. If the reservoir is constructed, periodic flooding is expected to decrease the value of the trout fishery within the project area. In so far as possible all waters within the reservoir flow line should have free public access for fishing purposes. Consideration should be given to the establishment of a pool directly behind the dam. Water held at 310 elevation would provide a 25 acre pond while utilizing only approximately 2.5% of total reservoir storage capacity.

Meadow Pond Brook

This reservoir, which would be located in Naugatuck and Middlebury, Connecticut, would be 180 acres in gross acreage. Most of the project lands provide excellent rabbit habitat and fair to good pheasant habitat. Fair conditions for squirrels are found on the fringe of project lands. Losses to wildlife are not expected to be severe provided lands and easements are made available to the public for hunting purposes.

Meadow Pond Brook is stocked with trout annually by the State and receives moderate fishing pressure from local anglers. Losses to the value of the stream fishery are expected to be only slight if free public access is provided for purposes of fishing.

Little River

Located in the community of Oxford, near Seymour, Connecticut Little River Reservoir would inundate 128 acres at maximum flow line. Squirrels and rabbits comprise the wildlife resource and they are, of necessity, rather limited. While it is expected that losses to wildlife would be slight if the project is completed, it is important that development planning provide for free public access to project lands for hunting purposes.

Little River is an important trout stream locally and receives substantial annual stocking by the State. The stream receives moderate fishing pressure from nearby communities. Losses to the trout fishery are not expected to be severe provided the public has free access to the project area waters for fishing purposes.

Bladens River

Located in the towns of Seymour, Bethany, and Woodbridge, the proposed Bladens River Reservoir would inundate 240 acres at spillway level. A considerable portion of this acreage is good to excellent habitat for rabbits and squirrels, and good habitat for pheasant. Losses to wildlife resources could be severe unless provisions are made for free public access to project lands for hunting purposes. An excellent opportunity is presented for the development of a subimpoundment to benefit waterfowl. The proposed relocated section of State Highway 67 that crosses Black Brook could act as a dam. Controlled by a drop inlet structure to elevation 260, such a pond would be valuable for waterfowl.

Bladens River is stocked annually by the State and is fished by local anglers. If the project is completed the trout fishery would be subject to moderate loss. Provision should be made for free public access to all waters within the reservoir area for fishing purposes. Within the reservoir flow line are six ponds with a total of approximately 7.5 acres. One is a much used public swimming pool, the largest (about 3 acres) is a commercial skating rink, and the others are private ponds used for fishing and other general recreation. A pond on Black Brook, as suggested for waterfowl, would also have moderate fishery benefits. It is also suggested that a permanent pool be considered directly behind the dam at 220 elevation. Such a pool, approximately 10.5 acres in size and utilizing approximately 1.5% of the reservoir storage capacity, would have moderate value for fishing and other general recreation.

FEDERAL POWER COMMISSION

REGIONAL OFFICE

FEDERAL POWER COMMISSION
REGIONAL OFFICE
139 CENTRE STREET
NEW YORK 13, NEW YORK

December 21, 1956

The Division Engineer
New England Division
Corps of Engineers, U. S. Army
150 Causeway Street
Boston 14, Massachusetts

Subject: Proposed Flood Control Reservoirs on Naugatuck River below Thomaston, Connecticut

Dear Sir:

Reference is made to your letter of October 24, 1956, transmitting project data and maps for eight proposed reservoirs located on tributaries of the Naugatuck River, Connecticut, and requesting our comments on the power potentialities of these projects.

The eight projects under consideration include earth fill dams on Northfield Brook, Branch Brook, Hancock Brook, Mad River (enlargement of Scoville Dam), Hop Brook, Meadow Pond Brook, Little River and Bladens River. These projects in the aggregate would provide 49,000 acre-feet of flood control storage, equivalent to about 10 inches of runoff from the combined 93-square mile tributary drainage area above the dams. Individual project drainage areas range from a maximum of 22.8 square miles to a minimum of 5.7 square miles. It is proposed to operate all reservoirs solely in the interest of flood control, with the exception of Scoville reservoir on Mad River where existing storage for industrial water supply would be maintained with flood control storage added above the existing maximum permanent pool. No data have been made available with respect to project costs and economic feasibility.

Under the proposed method of operation of the projects for flood control only and in view of their relatively small tributary drainage areas, our studies indicate that costs associated with enlargement of the dams and reservoirs to provide power head and storage would not be justified on the basis of the value of the small amount of power that could be developed thereby. If, in the future, conservation storage is needed for water supply, low flow improvement and recreation, some of the projects including Branch Brook, Scoville, Hop Brook, Bladens River and the proposed Thomaston reservoir appear suitable for providing such storage without reducing the established flood control storage capacity. This could be accomplished by the installation of spillway gates to control the surcharge storage available between permanent spillway crest and the maximum flood control pool level.

Based on our examination of your plans and related data on the proposed eight flood control projects, it is concluded that no modifications in the plans for the dams and reservoirs are warranted for the purpose of power development.

Sincerely yours,

D J Wait

D. J. Wait
Regional Engineer

IN REPLY REFER TO:
L7423

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
Region Five
421 Walnut Street
Philadelphia 6, Pa.

May 23, 1958

Lt. Col. Miles L. Wachendorf
Asst. Div. Engineer for Civil Works
U. S. Army Engineer Division, New England
Corps of Engineers
150 Causeway Street
Boston 14, Massachusetts

Dear Col. Wachendorf:

In reply to your letter of May 21, I wish to thank you for calling to our attention the four potential flood control dams and reservoirs currently under consideration, Black Rock, Hancock, Northfield Brook, and Hop Brook, all in Connecticut.

It is very probable that archeological salvage may be involved at any or all of these sites, but definite information as to the presence of historic or prehistoric values in or on the ground must await survey. The reservoir areas lie near heavily populated areas where historic occupation was early and prehistoric settlements undoubtedly existed.

I have discussed these reservoirs with Mr. William A. Slagle, Project Engineer, Division of New England Flood Studies, of your Office, last week, and have explained to him our practice in the National Park Service heretofore of making archeological surveys only in reservoir areas of projects definitely authorized. Mr. Slagle explained that information concerning possible archeological values was sought for preliminary surveys in advance of authorization.

In order to obtain any information which may at this time be available concerning either historic or prehistoric sites in these proposed reservoirs, prior to surveys which may later be contracted for by The National Park Service, I am forwarding your map to Dr. Irving Rouse, Chairman of the Department of Anthropology, Yale University, and asking him if any sites are presently known to exist in the reservoirs marked. Any information we can gather through inquiry will be forwarded to you.

Sincerely,

John L. Cotter

John L. Cotter
Regional Archeologist

EXHIBIT 6

STATE OF CONNECTICUT

WATER RESOURCES COMMISSION

STATE OFFICE BUILDING · HARTFORD 15, CONNECTICUT

June 3, 1958

General Alden K. Sibley
Division Engineer
U. S. Army Engineer Division, New England
Corps of Engineers
150 Causeway Street
Boston 14, Mass.

Dear General Sibley:

This will refer to your letter of May 8th requesting the formal comments of this Commission concerning the four proposed flood control dams located on tributaries of the Naugatuck River below the Thomaston Dam.

The Commission is delighted to learn that out of the fourteen potential reservoirs investigated under the Northeast Flood Studies Program that it has been found that four of these dams are economically justified. These reservoirs being located on Northfield Brook; Branch Brook; Hancock Brook and Hop Brook. Obviously the construction of these four dams in addition to the Thomaston Dam and the two proposed dams on the east and west branches of the Naugatuck River above Torrington will provide a very substantial protection to properties and assets in the Naugatuck River Valley.

The Commission has reviewed the pertinent information pertaining to these four dams and has reviewed with its staff the various factors affecting the construction and location of them. The Commission, therefore, in general, approves of the construction of these dams and hopes that every step will be taken to expedite their design and construction so that they will become useful flood protection works in the valley at an early date.

EXHIBIT 7-1

In your letter you state that no other local protection projects have been found economically feasible as a result of these studies. It is assumed that this does not preclude further investigations of any other flood control projects or local protection works if conditions in the future warrant such further investigations.

Sincerely yours,

William S. Wise

William S. Wise
Director

WSWgd

STATE OF CONNECTICUT

BOARD OF FISHERIES AND GAME

2 WETHERSFIELD AVENUE · HARTFORD, CONNECTICUT

ADDRESS ALL MAIL TO
STATE OFFICE BUILDING, HARTFORD 15

December 28, 1956

Division Engineer
Corps of Engineers, U. S. Army
New England Division
150 Causeway Street
Boston 14, Massachusetts

Dear Sir:

RE: File No. NEDGW

Reference is made to notices of hearing on proposed flood control impoundments to be constructed on the Farmington and Naugatuck River systems.

The position of this agency regarding impoundments on these river systems is that every effort should be made to acquire the flowage areas under terms which would permit public use for out-of-door recreation such as hunting and fishing within the flowage areas.

The U. S. Fish and Wildlife Service collaborates closely with biologists from this agency and is studying the effect of each impoundment upon wildlife, and these studies, conclusions, and recommendations are transmitted to your office. In each case, the statements made by the Fish and Wildlife Service relative to these impoundments have my complete endorsement.

Very truly yours,

Lyle M. Thorpe

Lyle M. Thorpe
DIRECTOR

LMT/fc

EXHIBIT 8

STATE OF CONNECTICUT

THE NAUGATUCK VALLEY RIVER CONTROL COMMISSION

ONE CENTRAL AVENUE
WATERBURY, CONNECTICUT

PLAZA 5-0175

May 23, 1958

Brig. General Alden K. Sibley
Corps of Engineers, U.S. Army
150 Causeway Street
Boston 14, Mass.

Dear General Sibley:

Thank you for your letter of May 8 in which you request comment on proposed flood control dams in the Naugatuck River Basin located on Northfield Brook, Branch Brook (Black Rock), Hancock Brook and Hop Brook.

Your records will show that we recommended that study be made of 14 sites. The above named sites were included. Your Division has from time to time kept us advised of progress of these studies as well as of the studies of other flood protection works which we felt required attention. We are grateful to you for your careful consideration and fine cooperation.

In passing however, we urge that the door not be closed to further consideration of other protective projects, in addition to Bush-McCormack projects, which we have recommended. We say this because it is implied in the second paragraph of your letter that you do not intend to consider further projects. This paragraph reads: "With the exception of those projects being considered under the provisions of the Bush-McCormack Act (Public Law 685) no local protection projects have been found economically feasible".

Our Commission with the aid of its Engineering Advisory Group, has studied the location maps and all other data of the 4 proposed reservoir sites which you have previously supplied. We have been impressed with the protection which you and we have determined will be afforded. We have also been impressed with the figures shown on the "Pertinent Data"Sheet which accompanied your letter of May 8 including the favorable benefit cost ratios.

We believe that these 4 projects can conscientiously and rightly be approved and authorized in the best interests and to the general benefit of the Federal Government, the State and the people of the Valley who have endured repeated disastrous floods including the most recent ones of August and October 1955.

Yours very truly,

C. L. Eyanson

Chairman

C.L. Eyanson/ac

EXHIBIT 9